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J. H. Muxley
Harvey

Structure of the Crossoplenyzian fauna

MEMOIRS
OF THE
GEOLOGICAL SURVEY
OF
THE UNITED KINGDOM.

Figures and Descriptions
ILLUSTRATIVE OF
BRITISH ORGANIC REMAINS.
—
DECADE XII.
—

ILLUSTRATIONS OF THE STRUCTURE OF THE
CROSSOPTERIGIAN GANOIDS,

BY THOMAS H. HUXLEY, F.R.S.,
NATURALIST TO THE GEOLOGICAL SURVEY OF GREAT BRITAIN.

PUBLISHED BY ORDER OF THE LORDS COMMISSIONERS OF HER MAJESTY'S TREASURY.

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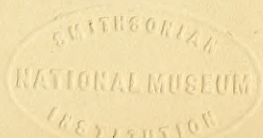
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BRITISH FOSSILS.

DECADE THE TWELFTH.

ILLUSTRATIONS OF THE STRUCTURE OF THE CROSSOPTERYGIAN GANOIDS;

BY

THOMAS H. HUXLEY, F.R.S.

I.—THE GENUS GLYPTOPOMUS.

At p. 57 of the "Poissons Fossiles du Vieux Grès Rouge," Prof. Agassiz remarks, in establishing this genus, that he at first took the only specimen known to him for a *Platygnathus*; and it is figured in the 26th plate as *Platygnathus minor*. He describes the unique specimen of *Glyptopomus minor* in the following terms:—

"This fish, of which I know but a single specimen, obtained at Dura Den, and placed in the collection of Prof. Jameson, has the body wide and heavy, and resembling in form that of *Holoptychius*. It lies on its belly, and is turned a little to the left side, so that it is the back and right side which are visible. The head is proportionably small, and composed of enamelled and irregularly sculptured bones, which appear to be covered with a thick and very variable granulation. In the middle of the head it is easy to distinguish the frontals; in front, the nasals; behind, the occipital; and a great lateral enamelled plate, which indicates that the cheek was covered, as in *Polypterus*, by a single osseous lamella, below which the great masticatory muscle was fixed.

"The scales of the body are very considerable, very high on the sides, almost square on the back. They form oblique series, which meet at an acute angle in the middle line of the back. The scales themselves are very thick, placed side by side, apparently connected together only by the integument in which they were implanted. Their enamelled surface is not smooth, but adorned with a fine granulation, which gives them a velvety aspect. I have been unable to examine their microscopic structure.

"Only a few traces of fins are preserved in the specimen figured; probably a portion of the ventral near the throat, and a vestige of the dorsal, or caudal, near the end of the tail. The fin rays seem to have been short and delicate."

In the "Preliminary Essay" of the "Tenth Decade" I described and gave a woodcut of the skull, represented in Plate I., fig. 2, of the present decade; and in a note at the end of that

Essay, I briefly adverted to the addition made to our knowledge of the genus by the specimen received from Dr. Taylor of Elgin, which I now proceed to describe at length.

GLYPTOPOMUS MINOR. (Pl. I., fig. 1.)

This is a cast, in tolerably fine-grained sandstone, of an entire specimen of *Glyptopomus*, the parts of which have undergone very little derangement. The sandstone block in which the fish has been preserved is split into two slabs, along a plane traversing the body of the fish, and, in general, midway between its dorsal and ventral surfaces. The one slab (fig. 1, Pl. I.) therefore, contains, for the most part, the impression of the dorsal surface of the fish, while the other exhibits the impression of its ventral surface; but the plane of splitting has not traversed the head, so that the impression of the jugular plates and lower jaw is left on both slabs. On the one, or dorsal slab, however, it is the impress of the inner surface of the bone of these parts which is shown, while, on the other, the outer or sculptured surface has left its mark.

The total length of the body of this fish is $13\frac{3}{4}$ inches; it attains its greatest width ($2\frac{3}{4}$ inches) in the middle of its length. Some allowance must be made, however, for the compression to which the fish has been subjected.

The greatest length of the head, measured in the middle line, from the anterior end of the snout to the level of the posterior margins of the opercular apparatus, is $2\frac{3}{4}$ inches, or about one-fifth the length of the body.

The principal jugular plates (*G*) are each 2 inches long by about three-quarters of an inch wide at widest. The impression of their surfaces shows that they had had a finely-ridged, more or less granular, sculpture. There is no median jugular plate, and there is no positive evidence of the existence of any lateral jugular plates.

Behind, and partially overlapped by, the two principal jugular plates there is evidence of two triangular sculptured plates belonging to the pectoral arch; and behind these commence the series of ventral scales, which are irregularly four-sided, about a quarter of an inch wide by one-sixth of an inch long, and are disposed in transverse rows, which converge obliquely from above and without, downwards and inwards, to the middle line. The surface of the cast of each scale exhibits a multitude of minute hemispherical elevations, corresponding with the pits which constitute the well-known ornamentation of the scales of this genus.

The median dorsal scales are irregularly hexagonal, and the rows of lateral dorsal scales run from them as a centre, downwards and backwards, on each side, to pass into the lateral ventral series. The most anterior and largest of these median scales are as much as four-tenths of an inch wide by a quarter of an inch in length.

Fig. 1.

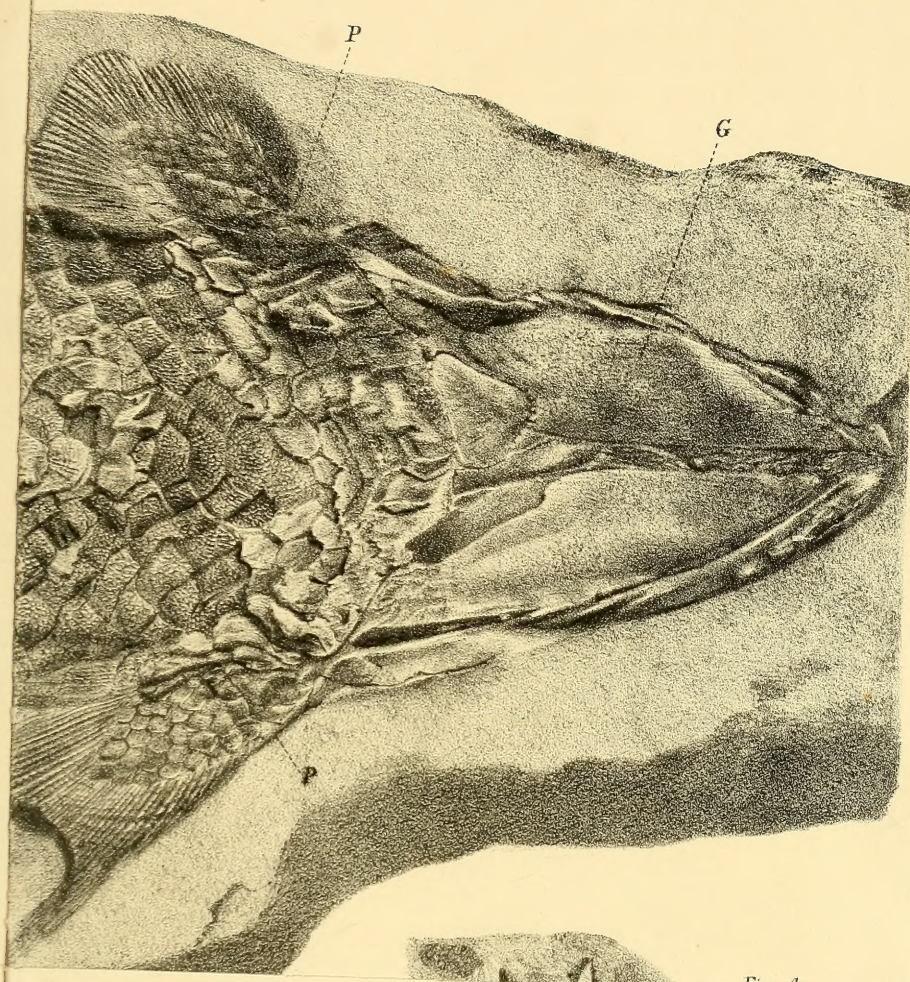


Fig. 4.



Fig. 1.

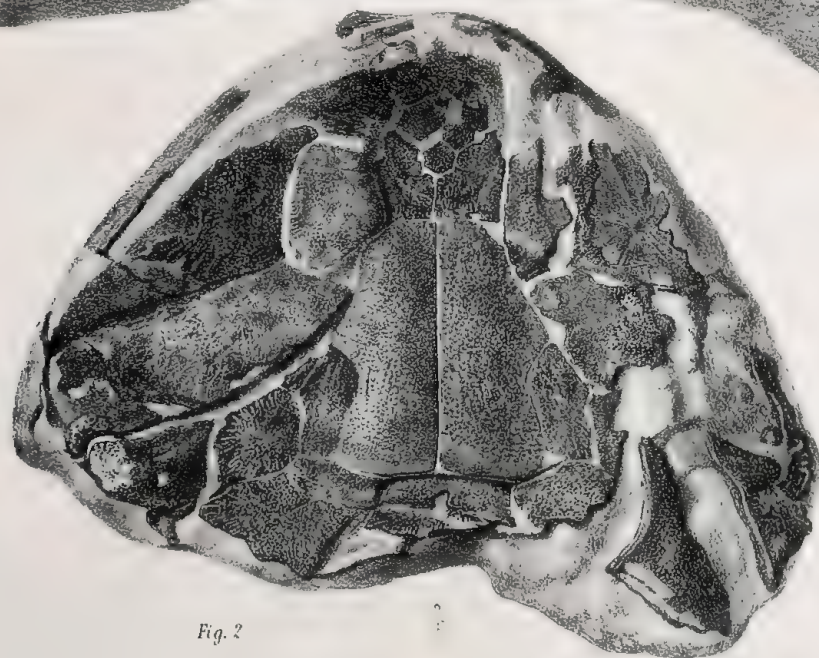
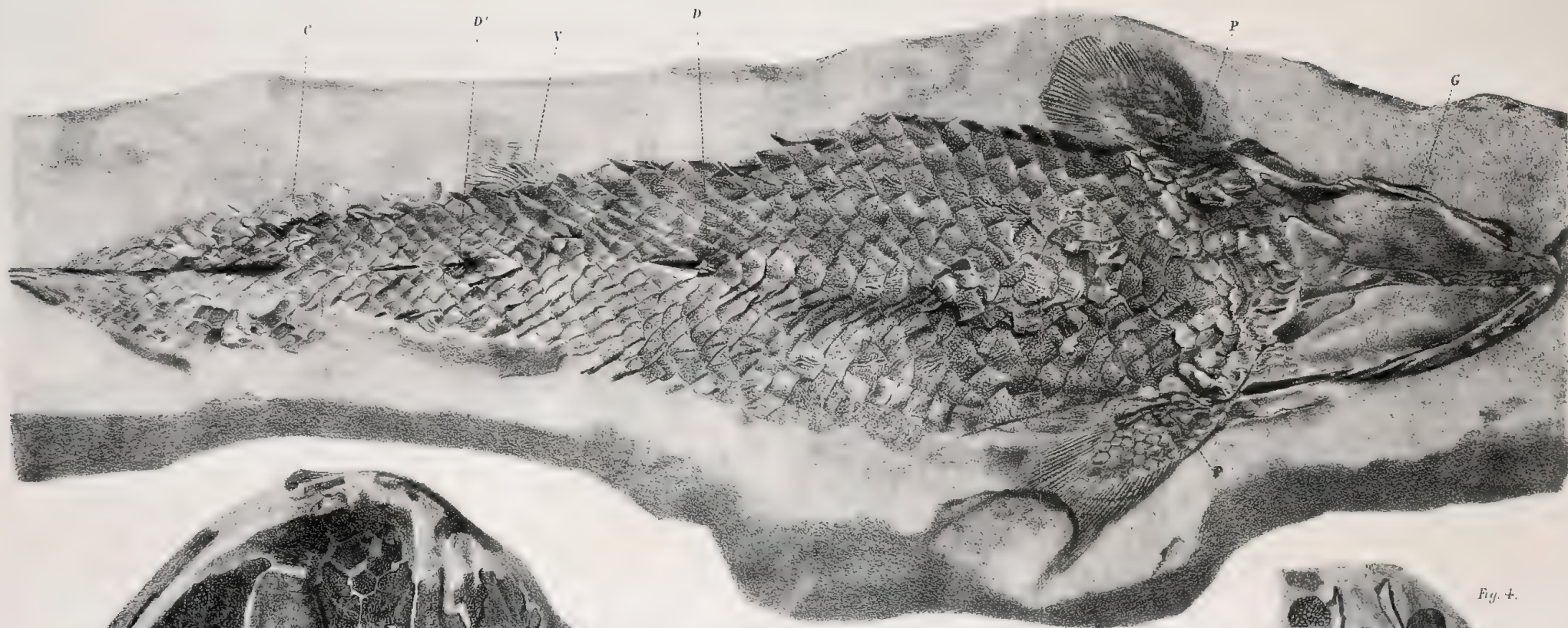


Fig. 2

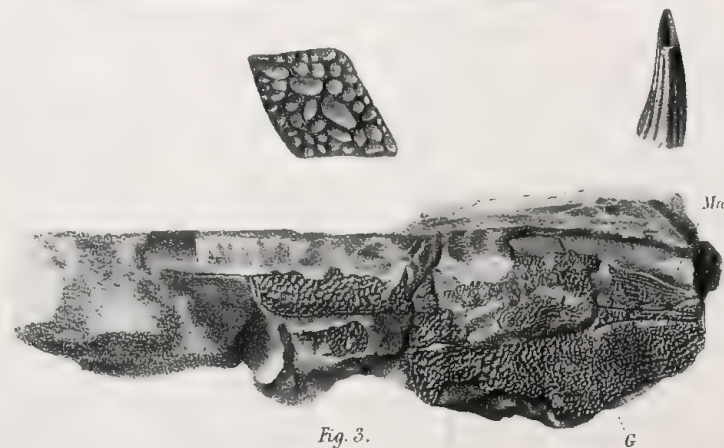


Fig. 3.



Fig. 4.

The general character of the sculpture is the same on the dorsal as on the ventral scales. On the right side of the body some few of the scales in the position of the lateral line exhibit a grooved character, which is somewhat more prominent in the figure than it appears to my eye to be in nature.

The impression of the anterior dorsal fin (*D*) commences at seven inches and three-tenths from the anterior extremity of the muzzle; that of the second dorsal (*D*¹) at about nine inches and a half from the same point.

The fin rays of the ventrals (*V*) are visible on one side in the dorsal impression (fig. 1), and, on both sides, in the ventral cast, just in front of the second dorsal. They seem to have been broad, but far shorter than the pectorals, and the impressions are so indistinct that I cannot say whether they are lobate or not.

The pectoral fins (*P*, *P*,) are exquisitely displayed; each has a broad scaly lobe, subacute at the extremity, and more than an inch long, by half an inch wide. The scales exhibit the same sculpture as those on the body, but are much smaller, and diminish in size towards the apex of the lobe. The many-jointed fin rays are attached all round the margins of the lobe, and become longer towards its apex, where they form fully half of the length of the fin.

I see no trace of the anal fin in either slab. The impression of the well-defined upper lobe of the caudal (*C*) commences at eleven inches and a quarter from the anterior extremity of the muzzle. The lower lobe is not well shown in either slab; but I suspect from the size of the upper, that the tail is diphycercal.

The only tooth of *Glyptopomus* I have seen, fig. 4, is stout, conical, slightly curved, and deeply grooved longitudinally.

The jugular plates and the mandibles have a coarsely pitted and ridged sculpture (Pl. I., fig. 3).

These facts leave no doubt as to the position of *Glyptopomus* in the Glyptodipterine family of the suborder *Crossopterygida* among the *Ganoidei*.

DESCRIPTION OF PLATE I.

- Fig. 1. The cast of a specimen of *Glyptopomus minor*. In Dr. Taylor's Collection. *Nat. size.*
- Fig. 2. The skull of a larger *Glyptopomus* viewed from above. It is described in Decade X. "Introductory Essay," p. 4. In the British Museum. *Two-thirds of the size of nature.*
- Fig. 3. A fragment showing the sculpture of the jugular plates (*G*) and the mandible (*Mn*). In the Museum of Practical Geology. *Nat. size.*
- Fig. 6. A slab with well preserved scales and a tooth of *Glyptopomus*. *Nat. size.* The tooth and one of the scales are represented separately and magnified.

II.—ILLUSTRATIONS OF THE STRUCTURE OF THE CÆLACANTHINI.

1. *The genera CÆLACANTHUS and UNDINA.*

In the "Preliminary Essay upon the Systematic Arrangement of the Fishes of the Devonian Epoch," prefixed to the tenth decade of the "Figures and Descriptions illustrating British Organic Remains" (1861), I have endeavoured to prove that the genera *Cælacanthus*, *Undina*, and *Macropoma* constitute a very distinct family of the Crossopterygian Ganoids, to which the term *Cælacanthini* ought to be restricted.

At the time of the publication of this essay I was unaware that, in 1858, the late eminent paleontologist, M. Thiollière, had enunciated the same conclusion in the following terms:—

"La famille des Cælacanthes comprendrait à la fois, suivant son auteur, les *Sudis* de la faune actuelle, le *Glyptolepis leptopterus* du vieux grès rouge, et le *Cælacanthus granulosus* du terrain permien. Ce sont pourtant là trois types ichthyologiques beaucoup trop différents pour être ainsi réunis. Mais, si l'on exclut les deux premiers et qu'on associe au genre *Cælacanthus* lui-même les *Macropoma* de la craie et les *Undina* du Jura, on obtiendra le noyau d'une famille réellement naturelle, et que, pour éviter la confusion, M. Thiollière désignera par le nom d'*Ortho-cælacanthes*."*

It is to be regretted that only the abstract of this paper has been published, as it would have been very interesting to learn the grounds upon which M. Thiollière's conclusion is based, and which are not stated in the "Note" whence the foregoing passage is extracted.

My own view of the common characters of these genera is given in the following definition of the suborder *Crossopterygidae* and family *Cælacanthini* ("Preliminary Essay," p. 26).

Suborder CROSSOPTERYGIDÆ.

Dorsal fins two, or if single multifid or very long; the pectoral and, usually, the ventral fins lobate; no branchiostegal rays, but two principal, with sometimes lateral and median, jugular plates situated between the rami of the mandible; caudal fin diphycercal or heterocercal; scales cycloid or rhomboid, smooth or sculptured.

Fam. CÆLACANTHINI.

Dorsal fins two, each supported by a single interspinous bone; paired fins obtusely lobate; air-bladder ossified.

Since 1861 I have studied a considerable number of specimens

* *Note sur les poissons fossiles du Bugey, et sur l'application de la Méthode de Cuvier à leur classement*; par M. Thiollière. Printed in abstract in the "Bulletin de la Société Géologique de France," Sc. 2, I. xv., pp. 782-793, 1858.

of Cœlacanthines belonging to the genera *Cœlacanthus* and *Macropoma*, without finding any reason to modify the definitions just given; but the materials which have passed through my hands enable me to illustrate the structure of these genera more fully than has hitherto been possible.

I commence these illustrations with the genus *Cœlacanthus*, for the opportunity of examining numerous specimens of which I am indebted to the Earl of Enniskillen, Sir Philip Grey Egerton, Bart., Dr. Rankine, of Carlisle, Edward Binney, Esq., F.R.S. of Manchester, Dr. Garner, and Messrs. Molyneux, Ward, and Weston.

The Genus *CÆLACANTHUS*, Agassiz.

The name *Cælacanthus* was first applied to a genus of fossil fishes by Agassiz, in the feuilleton of his "Recherches sur les Poissons fossiles," dated March 1836*; and figures of the fragments from the Magnesian Limestone of Durham, to which he applied the title of *Cælacanthus granulatus*, were published in 1839, in Plate 62 of the second volume of that work.

Furthermore, in the systematic catalogue of the fossil fishes in the collections of Lord Enniskillen and Sir Philip Egerton, the family *Cælacanthes* had been established for the genera *Cælacanthus*, *Holoptychius*, and *Macropoma*, with two additional species of *Cælacanthus*, *C. lepturus* and *C. gracilis*, from the Carboniferous formation.

But no description of these specimens, or diagnoses of the genera, had appeared in 1842, when Count Münster published the fifth part of his "Beiträge zur Petrefacten-Kunde," containing figures and descriptions of the fishes from the Lithographic slates which he names *Cælacanthus striolaris* and *C. Köhleri*.

Count Münster, however, had already published notices of these fishes in Bronn's "Jahrbuch," for 1842, and had applied the generic title of *Undina* to them. And he remarks, that if Agassiz' genus *Cælacanthus* from the older formations is provided, like *Macropoma*, with conical teeth, the otherwise very similar fishes from the Lithographic slates would belong to a different genus, for which the title of *Undina* might be retained.

With this proviso Münster continues his description, as follows:—

"Genus *CÆLACANTHUS*, Agassiz.†

"Teeth flat, strongly granulated: scales thin, elongated, rounded off: two dorsal fins: caudal fin very large and broad, vertebral column traversing the middle of it, and forming at its point a second small pencil-like fin. Skeleton, with the exception of the vertebral column, bony; body elongated.

"1. *Cælacanthus striolaris*

I am acquainted with four specimens of this species, all of which were found at Kelheim, on the right bank of the Danube. The largest of them in my collection, measures a foot (Rhenish) from the head to the tip of the tail, and three inches five lines in breadth, without the fins; the smallest specimen, in which the apex of the head is wanting, is nine inches long and two inches six lines broad. The former is depicted in the second plate, but, since the thoracic and abdominal fins are not well preserved in the original, I have supplied these parts in the figure from other specimens. Both specimens, as well as a third, which I have had the opportunity of examining, lie upon one side, and exhibit a slightly convex back and an almost straight ventral line. The head is small, the forehead strongly arched; the bones of the head, however, are very brittle, and hence are badly preserved. Of the teeth only a few, as well

* See Count Münster's "Beitrag" Heft, V. 1842.

† The references to the figures are, for the most part, omitted in this translation.

in the upper as in the lower jaw, are visible, and are seen, above, from the side, below, from the upper surface. Whether more than one series exists is not clearly discernible. The most distinct are a few teeth of the lower jaw, which are represented magnified in figure 8, have an angular flat form, and are strongly granular upon their upper surface; within these teeth a few others which were more rounded off appear to have been implanted in the lower jaw. The bone of the jaw, however, is so brittle that no more exact determination of this point can be made.

"The scales are relatively large, but so thin and so closely united together, that in a few spots, especially towards and amidst the caudal fin, they appear like a finely-striated membrane.

"They all exhibit fine, short, elevated ridges, and only the cervical scales are somewhat granular at their external ends. But the peculiar fins most especially characterize this fish.

"The first of the two dorsal fins, which lies over the pectoral fin, has eight simple rays, which, in their proximal halves, are deeply grooved, thick, and crenulated on the outer edge; on the upper side, towards the point, however, they are flat and closely jointed. The second dorsal fin has 13 or 14 flat, closely-jointed, rays, somewhat depressed in their middle part and grooved towards the root. This fin is placed directly over the anal fin, which has a perfectly similar size and composition. Fig. 14 depicts one of the median rays. The ventral fin is small, but indistinct and weathered. The pectoral fin has 13 or 14 flat closely-articulated rays, just like the two dorsal and the ventral fins. Most remarkable, however, is the broad caudal fin, which is divided by the unossified vertebral column into two halves, the upper of which bears 20-21 rays, the lower 18-19, which form prolongations of the vertebral processes. The outer side of the deeply-grooved rays is very finely notched, almost toothed; the thick spinal column forms, at the end of the two caudal fins, a pointed pencil-like second caudal fin, with 20 or 30 short flat closely-jointed rays. The unossified spinal column is finely striated: in the middle of it very short bones in pairs appear. The spinous processes are continued along the whole dorsum of the spinal column. Neither ribs nor special bodies of vertebrae are visible. In these specimens the stomach of the fish is rendered obvious by a depression, with a smooth shell-like investment, like what may be seen in most specimens of *Macropoma Mantelli*.

"2. *Cœlacanthus Kohleri*.

"I know of only one imperfect specimen of this species, for which I am indebted to the kindness of M. Kohler. The greater part of the head, with the pectoral and ventral fin of this individual, are wanting. It was at least one-third larger than the largest specimen of the preceding species, from which it is especially distinguished by its scales, which are covered with raised elongated points, almost like flies' eggs. The few scales whose external form is recognizable, resemble those of the preceding species, but are larger, and have elongated granulations upon their surface.

"The fins closely resemble those of the foregoing species. The first dorsal has nine thick rays, which are very long, and are distinguished from those of the preceding species by the rows of small spines which beset their outer sides as far as the middle. The point is flat and closely articulated.

"The second dorsal has 19 or 20 very broad, sharp-pointed rays, which are so close together that they come into contact in the middle.

"The anal fin is constructed like the preceding.

"The broad caudal fin is distinguished from that of the preceding species by a greater number of rays, and especially by many series of small spines on the outer side of the rays, as fig. 17 shows. In this species also the stomach with its smooth coat is visible."

Another species of *Cœlacanthus*, from the Kupferschiefer of Richelsdorf, is described by Count Münster, at p. 49 of the same part of his "Beiträge," under the name of *Cœlacanthus Hassiæ*. Though only a damaged skeleton without scales, it agrees closely, in general form as well as in its essential details, with *Cœlacanthus striolaris*.

The teeth are not recognizable. A few large scales lie scattered about. They are very large, but so thin that their proper form is not clearly distinguishable. However, they are all rounded off, smooth, raised from the exterior towards the middle, and correspondingly depressed below.

The anterior dorsal fin possesses ten very long, strong, simple rays, which are somewhat crenulated on the outer side, and jointed towards their end. The second dorsal fin has much finer articulated rays. The great ventral fin has long laterally crenulated rays; the vertebral column is unossified; the spinous processes of the vertebræ are only to be seen distinctly on the dorsal side of the vertebral column, and increase in size towards the tail.

It is clear from these descriptions that Count Münster was the first to indicate and define most of the great features of the organization of the Cœlacanthines, viz., the unossified vertebral column; the absent ribs; the shelly-walled internal organ, "like that of *Macropoma*"; the well-ossified head; the two dorsal fins; and the remarkable tail, with the singular characters of the fin rays.

Professor Agassiz first published his views respecting the Cœlacanthus in 1843, when the second part of the second volume of the "Recherches sur les Poissons Fossiles" appeared.

In treating of the "Family of the Cœlacanthus," he writes, at p. 168 of this work, as follows:

"THE FAMILY OF THE CŒLACANTHUS.

"I unite in this family many genera of an altogether peculiar physiognomy, but with whose true affinities I am, as yet, only very imperfectly acquainted. A remarkable peculiarity which has struck me in most of these fish, is the circumstance that their bones, and notably their fin rays, are all hollow internally, a peculiarity which is not met with in other ganoids, and which is the origin of the name "Cœlacanth" which has been conferred on the family. This character is especially striking in the true genus *Cœlacanthus*. To this singular structure of the bones is added another more apparent and more external character, viz., the form and disposition of the fins, and the mode of articulation of the rays; and, in the first place, most of the rays are stiff, or only articulated at their ends. Their combination with the apophyses [neural arches and spines] and inter-apophysial [inter-spinous] bones, is very singular,

especially in the caudal fin, the rays of which are supported by interspinous bones ; an arrangement which, in other fishes, is found ordinarily only in the anal and the dorsal [*caudale* in the text]. Lastly, the vertebral column is prolonged, more or less distinctly, between the principal lobes of the caudal fin, so as to form a median taper process."

Professor Agassiz then adverts to the resemblances and differences between *Cœlacanthus* and *Macropoma*, in a passage which I shall cite hereafter, and proceeds :

"Taking into account the extraordinary development of the dentary system in some genera of this family, and particularly in *Holoptychius*, one is tempted to approximate the Cœlacanths to the Sauroids ; whilst the dentition of the genus *Undina*, as it has been described by Prof. Münster, would seem to establish a closer affinity with the Pycnodonts. On the other hand, the scales exhibit peculiarities which are to be met with in no other family, whence I have been disposed to arrange the Cœlacanths provisionally between the Sauroids and the Pycnodonts. It may be, however, that their true place is near the Scleroderms, or the *Accipenseridæ*."

Of the genus *Cœlacanthus* itself, Professor Agassiz remarks (p. 170) :

"This genus, which I regard as the type of the family, was long known to me only by fragments ; but these were so different from most other ichthyolites, that I did not hesitate to form them into a distinct genus. What especially struck me was the form and the structure of the fins, their relation with the interspinous bones, and the manner in which the apophyses [vertebral arches and spines] are united on the one hand with the bodies of the vertebræ, and on the other with the interapophysial [interspinous] bones. The apophyses divide at their bases into two branches, forming a fork, which embraces the body of the vertebra ; to this apophysis succeeds an ossicle, which, instead of being interposed between two apophyses, is fitted on to the end of one, so as to form its direct prolongation. The ray properly so called, the longest of the three pieces, is also forked at its base ; its extremity alone is jointed, but never bifurcated. These three pieces, the apophysis, the inter-apophysial bone, and the ray, are about equal in length, and are all three hollow. This singular structure characterises most of the rays which lie at the posterior part of the body ; now as, usually, only the anal and the dorsal have inter-apophysial bones, I at first concluded that these two fins must be excessively developed ; and what helped to strengthen me in this idea, was the fact that the vertebral column appeared to be continued beyond the two azgyos fins, to form, further on, a bundle of very small articulated rays, attached directly to the vertebræ. But Lord Enniskillen's discovery of an entire specimen of this remarkable type has completely modified my views. It now appears that besides the fins of so exceptional a structure, which I regarded as anal and dorsal, this fish has a very distinct normal anal and two dorsals. Now, unless the existence of three dorsal and two anal fins of very different structure—an arrangement which occurs in no known genus of fishes—be admitted, it is necessary to regard the terminal fin of the body as a caudal. For the rest, this is not the only known example of a caudal supported by inter-apophysial bones, the caudal of *Polypterus bichir* being supported by similar bones, at least its upper lobe. What is truly exceptional is the prolongation of the tail beyond these rays, and the little fascicle of articulated rays surrounding its extremity. In this

respect my genus *Cœlacanthus* very nearly approaches the type of a fish from the Lithographic limestone of Kehlheim, for which Count Münster has proposed the generic name of *Undina*. But notwithstanding this analogy, and the altogether similar disposition of the other fins, the fish in question is distinguished by many peculiarities which do not permit it to be confounded with *Cœlacanthus*. The most important difference is presented by the dentition. The genus *Undina* has, according to Münster, pavement-like teeth, very similar to those of certain Pycnodonts. *Cœlacanthus*, on the other hand, has conical teeth, like the Sauroids, and everything leads to the belief that it is a carnivorous fish, so that, far from belonging to the same genus, it is doubtful whether it belongs to the same family. Leaving the caudal aside, the other fins of the genus *Cœlacanthus* present a very simple structure, composed of slender but not dichotomous rays. The first dorsal corresponds to the extremity of the pectorals. The second is opposite the space between the ventrals and the anal. The anal itself is very closely approximated to the caudal. This last fin (comprising in it the bundle of articulated rays which fringes the extremity of the vertebral column) nearly equals one-third of the total length of the fish. The vertebræ are much higher than they are long towards the anterior part of the trunk, but they become sensibly elongated posteriorly. It is the same with the apophyses, which, very slender in the abdominal region, take on a much greater development in the caudal region. The scales, to judge by the fragment of *C. granulosus*, are large, elongated, and have their posterior edge rounded. I have not been able to ascertain whether they are enamelled or not, but the fact that they are found in strata older than the Jura leads me to suppose that, as in all the fishes of that age, they were enamelled. Their extreme thinness, no doubt, has made them too fragile to be often preserved. I conclude from this description that the genus *Cœlacanthus*, although near the genus *Undina* of Count Münster, is nevertheless different from it, and that the latter should therefore form a separate type in the Cœlacanth family. Consequently it will be necessary to exclude from *Cœlacanthus*, and to place in *Undina*, the remarkable species which Count Münster has described and figured in the fifth part of his "Beiträge," under the names of *Cœlacanthus striolaris* and *Köhleri*. The true genus *Cœlacanthus* is at present restricted to the coal, the Zechstein and the Muschelkalk. I am acquainted with six species.

" *Cœlacanthus granulosus*, Agass. (Vol. 2, Tab. 62).

" The species to which I give this name was for a long time the only one known, and the two fragments which are figured were the only representatives of this remarkable family. Both represent the posterior part of a fish of very large size, which, to judge by the relative position of its fins, ought to have been at least two feet long As a general rule the apophyses (neural spines and arches) and the inter-apophysial bones are equal in length. The rays, on the other hand, are a little longer, but they are never jointed down to their bases. The cleft of the ray into which the point of the inter-apophysial bone is inserted is much narrower than that of the apophysis (neural arch), which embraces the vertebral column. It is probable, from all I have been able to see, that, in reality, these anomalous rays are composed of filaments [*filets*], as in most other fishes, only these filaments do not become separate. The rays at the extremity of the caudal fin are exceptions to the general rule, inasmuch as they are directly attached to the vertebral column, without being borne either by an apophysis, or

an inter-apophysial bone. They are articulated, and appeared to be divided at their apices. It is these little rays which I considered, at first, to belong to the true caudal fin. I have explained above, in speaking of the genus, the reasons which have led me to withdraw this opinion, when I had the good fortune to discover a complete specimen of the type in the collection of Lord Enniskillen. Thanks to this discovery, I have been able to investigate the form of the vertebræ, which I found very massive, like the rest of the vertebral column. It has also led me to consider as a caudal fin all that great fin, borne by interapophysial bones, above and below the extremity of the tail; and, as an anal, the simple fin which precedes them below. The anal is composed of much more delicate rays, which, however, equally possess the peculiarity of being bifurcated and articulated only at their ends. The anterior ones are completely undivided.

"The granular spots observable here and there on our specimens are remains of the integument. I have seen fragments of scales only in a portion of another species of Cœlacanth, and from their structure I do not doubt that our *Cœlacanthus granulatus* was covered with similar scales. They are very delicate, and the concentric rings are very readily distinguished in them. The raised granulations which ornament their surface have originated the name *C. granulatus*, which I have given to this species.

"It was found in the Magnesian limestone of East Hickley, and the originals of the plate are in M. Witham's collection.

"The species the description of which I reserve for the future, are—

"1°. *Cœlacanthus Phillipsii*, Agass. The caudal is more rounded than in *C. granulatus*, its rays are more close set and jointed nearer to their (proximal) ends. The apophyses of the caudal vertebræ are very long and delicate. The scales are large, and rounded posteriorly. From the Carboniferous rocks of Halifax.

"2°. *Cœlacanthus minor*, Agass. A very small species, remarkable for its very short inter-apophysial bones. The joints of the rays, properly so called, are longer than wide. The whole caudal is scarcely more than an inch long. From the Muschelkalk of Luneville.

"3°. *Cœlacanthus gracilis*, Agass. A species of unknown origin, distinguished by its elongated form; the pedicle of the tail, in particular, tapers evenly [*est tout d'une venue*], and its rays are less close set than in the other species.

"4°. *Cœlacanthus lepturus*, Agass. From the coal of Leeds. This species is still smaller than *C. minor*; its scales have rugose surfaces.

"5°. *Cœlacanthus Münsteri*, Agass. A beautiful species from the coal of Lebach, discovered by Lord Enniskillen, and characterized by its heavy form. It is in this species that I first saw the conical and hooked teeth of the genus *Cœlacanthus*."

The ascription of ossified vertebræ to *Cœlacanthus* is certainly erroneous, and in the "Preliminary Essay" (l. c. p. 16), I have already given the reasons which lead me to demur to Professor Agassiz's views regarding the systematic position and affinities of the Cœlacanthus. Furthermore I have shown that "*Cœlacanthus Münsteri* is not a *Cœlacanthus*; and, consequently, that so far as the arguments in favour of an essential difference between the dentition of *Undina* and *Cœlacanthus* are based upon the dentition of that fish, they are untenable.

In Professor King's "Monograph of the Permian Fossils,"

(1850), Sir Philip Egerton describes and figures a specimen of *Cœlacanthus granulatus* in his own collection.

"It shows little more of the fish than the figures given by Agassiz; but the scales are in a better state of preservation; they are irregularly rounded, and marked by fine undulating concentric lines. The enamel is thickly covered with the granulations which suggested the specific name. The second dorsal fin is also shown; it seems to have been larger and the rays thicker than in the anal fin opposed to it. The extremity of the tail is dislocated, and is seen in the lower part of the plate," p. 235.

The next page of the work cited contains the description of—

"Cœlacanthus caudalis.

"There is a charming little specimen, in the possession of Lord Enniskillen, of a *Cœlacanth*, which I am inclined to think can scarcely be referred to the preceding species. The entire length does not equal that of the tail of the smallest specimen of *Cœlacanthus granulatus* I have seen. The latter species is supposed by Agassiz to have been two feet in length; this fish measures only five inches. The head is rather more than a fifth of the total length; the second fifth includes the first dorsal, the third fifth extends to the back of the second dorsal, and from thence to the end of tail, occupies the two remaining fifths. This large proportion of the caudal region inclines me to adopt the specific name given above. The body is slender and of uniform size. The first dorsal fin is composed of about eight strong rays; these are carried upon thick inter-apophyses; and the corresponding neurapophyseal elements of the vertebræ are enlarged to support them. The same arrangement is seen in the second dorsal, but the fin rays are more slender and more numerous. The pectoral, ventral, and anal fins are of moderate dimensions and slender structure. The tail is broader, and terminates more abruptly, than that organ in *Cœlacanthus granulatus*."

The only other descriptions of *Cœlacanth*s (other than *Macropoma*) of which I have any knowledge, are contained in the following brief notes upon Carboniferous fishes of the United States, entitled "Description of several new genera and species of Fossil Fish from the Carboniferous Strata of Ohio," by Dr. Newberry, contained in the "Proceedings of the Academy of Natural Sciences of Philadelphia," vol. viii. p. 98, 1854.

"Cœlacanthus, Agass."

"1. *C. ROBUSTUS*, Newb. Body robust, 1 foot 6 inches in length; upper surface of cranium covered with small closely-approximated tubercles, maxillaries and opercula threaded with fine parallel, sometimes interrupted, lines. Margin of opercula in mature specimens wavy.

"Scales elliptical, thin, 7 to 9 lines in length, nearly half the surface exposed; exposed portion covered with thread-like lines, similar to those of the opercula and maxillaries, and which converge towards the posterior angle of the scale.

"*C. ORNATUS*, Newb. Body, fusiform, slender, scarcely wider

than the head; size small, not exceeding 4 to 5 inches in length; upper surface of head ornamented with tubercles, which are much larger and more remote than in preceding species; opercula and maxillaries threaded, and like the scales, having stronger markings than in the larger species.

“Radial formula, A.D. 8; P.D. 5; C. 24?; A. 6; V.?; P.?”

“*C. ELEGANS*, Newb. Body fusiform, robust, 6 to 8 inches in length; cranial surface covered with closely-approximated tubercles; surface of opercular and maxillary bones threaded. All the ornamenting of the head relatively stronger than in *C. robustus*, but less so than in *C. ornatus*. Scales similar in form and markings to those of both these species, but more delicate than either. Anterior dorsal fin slightly in advance of ventrals; posterior dorsal as much forward of anal fin.

“Radial formula, A.D. 7?; P.D. 5; C. 22; A. 6; V. 9?”

In the course of the preceding history of the gradual discrimination of the forms which constitute the genera *Cælacanthus* and *Undina*, the following species have been mentioned:—

Genus.	Species.	Formation.
		CARBONIFEROUS.
<i>Cælacanthus</i>	1. <i>lepturus</i> , Agassiz. 2. <i>Phillipsii</i> , Agassiz. 3. <i>robustus</i> , Newberry. 4. <i>ornatus</i> , Newberry. 5. <i>elegans</i> , Newberry.	
	6. <i>granulatus</i> , Agassiz. 7. <i>Hassia</i> , Münster. 8. <i>caudalis</i> , Egerton.	PERMIAN.
	9. <i>minor</i> , Agassiz.	TRIASSIC.
		OOLITIC.
<i>Undina</i>	10. <i>striolaris</i> , Münster. 11. <i>Kohleri</i> , Münster.	

Besides these there are *Cælacanthus gracilis*, Ag. of unknown locality and formation, and the so-called “*Cælacanthus*” Münsteri, which must be excluded from the genus *Cælacanthus*.

To the important question, how many of these nominal species are truly distinct, and what are their diagnostic characters, I must confess myself unable to give any satisfactory reply.

I have examined the specimens originally named *Cælacanthus lepturus* by Agassiz, in Lord Enniskillen's collection, and I entertain no doubt that the specimens from the Staffordshire coal-field described in the present decade are specifically identical with these; but I can find no certain diagnosis by which this species is to be distinguished from the *C. elegans* of Newberry (though I by no means affirm the identity of the two), and I have not seen *C. Phillipsii*, *C. robustus*, and *C. ornatus*.

I have examined specimens of *C. Hassiæ* and *C. granulatus* in Lord Enniskillen's collection. They are undoubted *Cœlacanthus*, a specimen of *C. Hassiæ* exhibiting the characteristic anterior dorsal interspinous bone, but no scales were preserved in any of the examples, nor were they in such a state as to allow of any useful comparison of the proportions of the body and fins.

C. caudalis is discussed below. Of *C. minor* I have seen no specimen, and Prof. Agassiz' diagnosis is insufficient to enable me to give any opinion concerning its specific distinctness.

Again, the differences between the genera *Cœlacanthus* and *Undina* appear to me to be anything but clearly made out. The close similarity of the two genera in the broad features of their structure is indubitable; and it is open to doubt whether the differences in the dentition are not more apparent than real.

Under these circumstances I shall adopt the generic and specific names, which have been used by my predecessors, provisionally, and without intending, for the present, to express any opinion as to their real value.

I. Cœlacanthus lepturus, Agassiz.

No. 1. The specimen represented in Pl. II., figs. 1, 2, 3, 4.

This fossil fish is nearly entire, only a small portion of its caudal extremity being absent. Its total length could not have exceeded five inches.

The length of the head appears to have been about 1·3 in., but the snout is somewhat crushed, and the occipital boundary is but indistinctly indicated.

The depth of the body, at the level of the anterior edge of the anterior dorsal fin (*D*) is 0·95 in. The anterior dorsal fin itself is 0·75 in. distant from the occiput, and 0·2 in. broad at its base. Twelve stout fin rays can be counted in it, the anterior three being shorter than the others, and gradually increasing in length to the fourth, which is about 0·75 in. long. I can discern no ornamentation upon any of these fin rays, which appear to be quite smooth, and become divided into broad quadrate joints in their distal moieties.

The remains of a large interspinous bone are seen at the base of the dorsal fin rays, and supporting them.

The fin rays of the second dorsal have disappeared, but I believe I can perceive indications of its interspinous bone.

The caudal fin (*C*) is very imperfect; the anal and pectoral fins are absent; but the right ventral (*V*) is seen in place, a little behind the level of the anterior dorsal. It is a considerable fin, as large as the anterior dorsal itself.

The scales of this fish are thin, flat, cycloidal, and 0·15 to 0·2 in. in diameter. The middle of the posterior margin of many of the scales (figs. 3 and 4) is produced, so that the exposed portion is nearly triangular. The sculpture consists of raised, continuous, ridges, which converge towards the middle line.

The pectoral arches are strong and broad, and have somewhat spatulate upper ends; they exhibit no sculpture.

Some points in the structure of the skull are so well displayed in this specimen that I have given an enlarged view of it in fig. 2.

The posterior moiety of the roof of the skull (*A*) meets the anterior at an obtuse angle, and exhibits no trace of sutures. The outer surface of this, apparently single, bony shield is ornamented with minute oval tubercles of enamel, which, posteriorly, run together into short ridges. Very little of the anterior moiety of the roof of the skull is preserved, but so much as remains shows a similar ornamentation.

The right operculum (*Op.*) is broad and triangular; its surface is marked by ridges, which take a radiating course from its anterior superior angle. These ridges are rather more interrupted, and as it were tuberculated, than they are shown to be in the figure.

Between the dislocated operculum and the suspensorial apparatus for the lower jaw, several ossified branchial arches (*Br.*) are visible.

The suspensorium itself consists of a closely united hyomandibular (*H.M.*) and palatoquadrate (*P. Qu.*) portion. The latter is a triangular strong plate of bone, and its downwardly and backwardly directed apex ends in a stout condyle for articulation with the mandible. Its upper edge is sharp and free, and its anterior thinner angle becomes connected with the skull, but, in what manner, the state of the specimen does not enable me to say.

The hyomandibular portion of the suspensorium is, inferiorly, covered by the palatoquadrate, but above, it appears, to be stout and prismatic. External to the anterior two-thirds of the outer edge of the palatoquadrate, what appear to be the remains of a maxilla are visible.

Emerging from beneath the anterior attachment of the palatoquadrate, there is a small process of bone which enlarges at its free end (*d*). A similar process, apparently developed from the prefrontal, is seen in *Macropoma* and *Undina*. In front of this, obscure traces of one or two sharp pointed teeth are visible.

The impressions of the right ramus of the lower jaw, and of one of the displaced jugular plates (*G*) are to be seen below the head.

This instructive specimen (like the others, unless the contrary be stated,) was obtained from the Coal measures of Pendleton by Mr. Molyneux, and is now in the Museum of Practical Geology.

No. 2. *The specimen represented in Pl. III., figs. 1., 1a., 1b.*

This is a figure, magnified to twice the natural size, of a small *Cœlacanthus lepturus*, not more than three and a half inches long, and so disposed as to display the unusually perfect caudal extremity very well.

The skull is about 0.7 in. long; and, posteriorly, where it is much crushed, it has about half that width.

It is seen from below, and the interspace between the rami of the mandible (*a, a*) is occupied by the two broad and elongated

jugular plates (*G*). The surface of each of these bones exhibits a very peculiar ornamentation, consisting of delicate undulating ridges, which, on the whole, run more or less parallel with the outer edges of the jugular plate, but, in front, converge towards its inner edge. The peculiar form and sculpture of the rami of the mandible, are better displayed by other specimens. In front of their symphysis there is a confused mass, doubtless formed chiefly by the premaxillæ, and which exhibits indications of small teeth.

The broad ends of the pectoral arches are displayed at *b*; but the pectoral fins are not visible.

The large, obtusely lobate, ventral is well shown at *V*. It has, at present, fourteen fin rays, which gradually increase in length on either side towards the middle four, which are about equal. These rays present no sculpture, but the broad jointing of their distal halves is very well displayed.

The remains of the dorsal fin appear at *D*.

The caudal fin has about ten fin rays above and below, which are connected with the neural spines by interspinous bones. The rays are jointed in their distal moieties; and the hindermost ones are shorter than the others, and lie more nearly parallel with the axis of the body. The latter narrows rapidly from the commencement of the caudal fin, and continues scaly to its truncated and evidently broken extremity.

The scales *a*, fig. 1*a*, have the same form and sculpture as in the preceding specimen. Fig. 1*b*. exhibits a magnified view of the ornamentation of part of one of the jugular plates.

No. 3. The specimen represented in Pl. III., fig. 2.

The chief interest of this specimen (figured of twice the natural size) arises from its showing at *b* the crushed walls of the ossified air bladder, and, at *a*, what appears to be the interspinous bone of the posterior dorsal fin. Its crura diverge at a somewhat more open angle than that shown in the figure. The anterior dorsal fin (*D*) of this specimen is unusually long.

*No. 4. The specimen represented in Pl. III., figs. 3, 3*a*, and Pl. IV., figs. 1 and 2.*

Of these figures the first is of the natural size; the two others are magnified, and fig. 2, Plate IV., has been accidentally inverted. They are taken from the two counterparts of a split specimen, and throw much light upon the structure of the mandible, the jugular plates, and the branchial apparatus.

Each ramus of the mandible (*Mn*), when viewed laterally, as in fig. 2, Plate IV. (which represents the right ramus) presents a nearly straight lower margin, while the upper edge is sinuous; the upper contour of the ramus attaining its greatest height rather behind its centre, and thence rapidly descending forwards and backwards. In the horizontal plane, the hinder part of each ramus is nearly straight, but its anterior end curves sharply inwards towards that of its fellow (Plate IV., fig. 1), to the symphysis.

The outer surface has an ornamentation composed of minute ridges of enamel, the ridges having a direction generally parallel with the axis of the ramus.

In the elongated oval jugular plate (*G*) of this specimen (Plate IV., fig. 1.), the ridges of the ornamentation are more completely transverse to the axis of the plate than in the specimen No. 3 (Plate III., fig. 2).

The impressions of five strong bony branchial arches are plainly visible on the left side. Minute horny, or osseous, filaments seem to have been set at right angles to the branchial arches along their edges (Plate IV., fig. 1).

Connecting the branchial arches is a strong median ossification, consisting of an anterior cruciform part, and a posterior elongated spatulate portion. The two anterior branchial arches are connected, the one with the outer end, and the other with the base, of a transverse arm of the cross; the three other arches unite with the sides of the posterior division, while the long spatulate end lies free between the hindmost pair of arches (Plate IV., fig. 1). Fig 3a. represents a scale of this specimen magnified.

No. 5. The specimen represented in Pl. IV., fig. 3.

The under surface of a crushed head of *Cœlacanthus lepturus*, showing the ornamentation of the jugular plates. In the collection of Edw. Binney, Esq. F.R.S.

No. 6. The specimen represented in Pl. IV., figs. 4 and 5.

These fragments, figured of the natural size, show, in fig. 4, the elongated pelvic bones still connected with a part of the ventral fins; and, in fig. 5, the anterior (*D*) and posterior (*D*¹) dorsal fins, apparently but little displaced from their normal position.

No. 8. The specimen represented in Pl. IV., fig. 6.

A very perfect hinder moiety of a *Cœlacanthus*, somewhat larger than any of the foregoing, drawn 1½ times the size of nature.

The persistent notochordal space, with the superior and inferior bony arches and spines, the interspinous bones, and the fin rays, are very clearly displayed. There seem to be 12, or perhaps 13, fin-rays in each lobe of the caudal fin; and, as in No. 2, the posterior fin-rays lie nearly parallel with the axis of the body. The jointing of the broad distal portion of these rays is very distinct. The scaly central part of the body (*C*¹) passes backwards into a prolongation about 0.1 in. wide, also covered with small scales, and beset along its upper and lower margins with small fin-rays, which appear to be simple and unjointed.

Cœlacanthus lepturus attained considerable dimensions. A specimen obtained by Mr. Molyneux from the Ladies Well Colliery,

Cheadle, North Staffordshire, shows that the parieto-occipital region of the head was at least 1.5 in. long, and that the length of the whole head could not have been less than $3\frac{1}{4}$ inches. The entire fish, therefore, was probably not less than 12 to 14 inches in length.

In this large specimen the surface of the parieto-occipital region, and of so much of the frontal region of the skull as is preserved, as well as that of the opercula, are covered with oval tubercles of enamel, set so closely as to leave no interspace. On the parieto-occipital shield these tubercles are about $\frac{1}{10}$ of an inch long, but on the opercula and the fragments of the external facial bones they become both actually and proportionally longer. The left pectoral fin is about an inch and a half long, and has a distinct, though small, scaly lobe. The ornamentation of the scales is quite as in the smaller specimens, but the scales are fully 0.3 in. in diameter.

II. *Cœlacanthus elegans*, Newberry.

I am indebted to Sir Philip Egerton, Bart., for the opportunity of studying several specimens of the *Cœlacanthus elegans* of Dr. Newberry, from Liston, Ohio, and I figure three of them for comparison with *Cœlacanthus lepturus*.

No 1. *The specimen represented in Pl. V., fig. 1.*

The caudal extremity of this specimen is broken off, but its extreme length, when entire, could hardly have exceeded 5.75 in. The length of the head is 1.3 in., so that the whole body was between four and five times as long as the head.

The fish is crushed in such a manner as to have its depth unnaturally increased, and the right ventral fin is seen to be detached, and lies below the left. From the line of the back at the front boundary of the first dorsal fin, to the opposite point of the belly is 1.4 in.

The scales, in a tolerably good state of preservation, are about 0.15 in. in diameter, thin and flat, and would be circular were not their posterior margins produced into an obtuse point (Plate V., fig. 3).

Each scale is ornamented with narrow, wavy, nearly parallel ridges, which converge towards and meet along a line drawn through the centre and the point of the scale. I observe no marked differences among the scales of different parts of the body, nor any trace of a lateral line.

The neural arches have the ordinary form, and are close set. A series of subvertebral arches correspond with them in the caudal region, but there is no more trace of ribs in this species than in *C. lepturus*.

Fourteen or fifteen fin rays, jointed in their distal portions, are discernible in the anterior dorsal fin (*D*), and seven or eight in the posterior (*D*¹), the anterior edge of which is opposite the most

anterior subvertebral bones. A large single interspinous bone supports the anterior dorsal fin, but the interspinous bone of the second dorsal is concealed.

The anal fin (*A*) is but obscurely indicated, but lies rather in front of the anterior margin of the second dorsal. The left ventral fin is in place, and is situated as in *C. lepturus*. The strong and broad bones of the pectoral arch are devoid of sculpture externally, and in form resemble those of *C. lepturus*.

The upper contours of the anterior and posterior regions of the skull do not pass evenly into one another, but meet at an obtuse angle. The operculum is large, extending from the roof of the skull to near the angle of the jaw, and has the form of a triangle with the base upwards. It is ornamented with fine ridges, which, on the whole, radiate from its anterior superior angle. The structure of the skull in front of the operculum cannot be deciphered.

The mandible is in place, though a good deal broken. So much of its outer surface as is preserved exhibits the characteristic sculpture.

Minute conical teeth are visible at the anterior end of the snout, and there is one in the palatine region, but these teeth are detached, and but obscurely visible.

No. 2. The specimen represented in Pl. V., fig. 2.

In this example the tail, with the anal (*A*) and second dorsal (*D*¹) fins, are well displayed. Twelve fin rays, having the same arrangement as in *C. lepturus*, can be counted above and below, and there is a medial scaly caudal prolongation, which, however, is not sufficiently preserved to show the small fin rays which it doubtless possessed.

No. 3. The specimen represented in Pl. V., fig. 4.

A much crushed head, showing the jugular plates and scales of *Celacanthus elegans*, and exhibiting three, or perhaps four, sharply pointed conical teeth, connected to all appearance with the premaxilla. The largest of these teeth is not more than 0.05 in. long. The ornamentation of the jugular plates is like that in *C. lepturus*.

III. Celacanthus caudalis, Egerton (Plate V., fig. 5).

Sir Philip Egerton's excellent account of this species has already been quoted at length, and I describe and figure the type specimen anew, merely for the purpose of comparing it with the *Celacanthus* already described, and of using it to supplement the information derived from them.

In fact, although the head of this specimen is much crushed, the extreme end of the tail is absent, and the scales are wanting, the skeleton of the trunk and fins has left the mark of its parts in almost undisturbed relation to one another.

The animal is a little bent up towards the dorsal side. Its length, measured in a straight line, is 4·7 in.; the head is 1·1 in. long, or, as in *C. elegans*, rather more than one-fifth the whole body. The front edge of the anterior dorsal fin (*D*) is distant 1·85 in. from the end of the snout, and the base of this fin is 0·25 in. long. From the front edge of the first dorsal to that of the second (*D*¹) is a distance of 0·95 in.; the base of the second is 0·2 in. long. The front edge of the upper lobe of the caudal fin (*C*) is 0·7 in. from the front edge of the second dorsal, and 3·6 in. from the end of the snout. Only the right pectoral fin, detached from the pectoral arch and thrown backward, is visible. The two ventrals (*V*) close together, and opposite the level of the posterior margin of the anterior dorsal, are apparently in, or close to, their natural position; they are distant 2·35 in. from the snout.

The small anal (*A*) is opposite the second dorsal, and 3·15 in. from the snout.

The greatest depth of the fish, 0·95 in., is opposite the first dorsal fin.

The pectoral fin (*P*) is rather more than 0·5 in. long, and 0·2 in. broad at its base; it is obtusely lobate, and contains, at fewest, 18 fin-rays. The foremost of these rays are unjointed through the greater part of their length.

The ventral fin (*V*) is 0·6 in. long and about 0·2 in. broad, or of nearly the same size as the pectoral. It is obtusely lobate, and 17 or 18 fin-rays may be counted in it. As in the pectoral fin, the foremost of these fin-rays are shorter than the others, and remain undivided through a great part of their length.

An impression of one, or both, of the pelvic bones (*Pv*) lies in front of the ventral fins, but apparently out of its normal position, as its base is in advance of these fins.

The anal fin (*A*) is somewhat bent upwards and backwards out of its natural position. What there is of it has a length of 0·4 in., a breadth at the base of 0·15 in. Fifteen or sixteen fin-rays may be counted, and they appear to be similar in structure to those of the pectoral and ventral fins. There is no evidence that this fin was lobate.

The base of the inferior lobe of the caudal fin (*C*) is 0·75 in. long, and exhibits 14 fin-rays, the hindmost of which are nearly parallel with the axis of the body, and probably indicate the natural termination of the fin. The anterior are shorter than the posterior fin-rays, and, so far as they are preserved, none of the fin-rays exhibit distinct joints.

The upper lobe of the caudal fin resembles the lower, and begins opposite to, or perhaps a little in advance of it.

The interspinous bones appear to correspond in number to the fin-rays, (unless there may be one or two in front which have no fin-rays,) and to be broader at each end than in the middle. Opposite the anterior end of the caudal fin, the whole depth of the body is about 0·65 in., and is divided into five nearly equal areas by the impression of the notochord in the middle and those of the vertebral arches and interspinous bones, above and below.

The second dorsal fin (D^1) contains 14 rays; its basal breadth is 0.2 in., its length not less than 0.5 in. The rays are slender, and only become jointed towards their extremities. The peculiar forked interspinous bone of this fin is not in its place, but I believe I can trace indications of it in the space between the lower edge of the first dorsal and the ends of the neural arches.

The first dorsal (D) is fully 0.8 in. long and 0.25 in. broad at the base; 11 or 12 fin rays can be counted, which are much stronger than those of the other fins, and, like the others, are only jointed at their tapering distal ends. I observe no spine-like tubercles upon these, any more than upon the other, fin-rays. The impression of the broad interspinous bone of this fin is plainly visible *in situ*.

About 23 close-set superior, or neural, ossified arches, occupying about 0.5 in., may be counted immediately behind the head. The spinal column is there interrupted for nearly the same distance, and a solitary neural arch is seen thrown down out of the series. Behind this point the neural arches are undisturbed, and opposite them, on the ventral side of the body, the series of subvertebral arches commences. That the point at which these commence is, in fact, part of the caudal region is shown by its relation to the position of the ventral fins. More than 40 neural arches can be counted behind the break, and there were therefore probably not fewer than 80 in the whole series. The number of subvertebral arches cannot be satisfactorily ascertained. There are no ribs in the dorsal region.

I am inclined to think that a distorted and V-shaped elevation which occupies the portion of the cavity of the body immediately under the anterior dorsal fin, is the remains of the ossified air bladder.

The head is so crushed that nothing definite can be made of its structure. The strong pectoral arches are discernible immediately behind it, but they also are much crushed.

No sculpture is visible upon what remains of the cranial bones.

IV. *Cœlacanthus elongatus*, Huxley.

The specimens to which I have applied this name, rather because I cannot identify them with any other species than because they have good positive characters of their own, are all mere impressions in shale, from Ballyhedy, near Ballinhassig, county of Cork, Ireland. They were sent to me by my colleague, Professor Jukes, the local director of the Geological Survey of Ireland, and are now in the collection of that Survey.

No. 1. *The specimen represented in Pl. V., fig. 6.*

This fish was probably about 3.5 in. long when entire. The head is somewhat less than one inch long, and appears more elongated and tapering in proportion than in the other species.

The anterior edge of the dorsal fin is 0.65 in. from the head,

and is thus further back in proportion; the depth of the body at this point is 0.5 in.

The cranial impression is marked by deep and irregularly disposed lines, the correspondence of which with the probable outline of the cranial and facial bones is not apparent. Besides and between these markings the impression of the skull presents traces of a minutely granular, or lineated, sculpture.

The anterior dorsal fin (*D*) is 0.5 in. long, but only eight or nine of its fin rays are preserved, and there is no trace of the interspinous bone. There is an interval of 0.7 in. between the bases of the anterior and posterior dorsal fins, and the latter (*D*¹) exhibits 13 or 14 long fin rays, with one or two short ones in front; the whole fin is 0.4 in. long.

The impressions of both bones of the pectoral arch are discernible, and the confused fin rays of apparently both pectoral fins (*P*). Each fin was about 1.5 in. long. About 37 neural arches may be counted, those nearest the head being smallest. There are no dorso-abdominal ribs, and the subventral bones begin nearly opposite the 25th neural arch. No ventral fins, nor any part of the caudal, are visible, in consequence of the breaking away of the matrix in their region.

No. 2. The specimen represented in Pl. V., fig. 7.

This is very like the preceding, but in some respects it is more complete. The extreme length is 3.6 in. The length of the head is about 0.85 in., unless the anterior end of the snout is absent. The head presents longitudinal and oblique groovings similar in their general character to those of the foregoing example: and, as in the latter, there is a rounded depression, like an orbit, situated at the junction of the posterior and the anterior three-fourths of the length of the head. Here and there, indications of a granular and lineated sculpture are visible. The impressions of the bones of the pectoral arch are well seen; they appear not to have been so rounded and expanded above as in the other *Cœlacanth*s.

Twenty-five dorsal abdominal neural arches, unaccompanied by ribs, can be counted (there were probably several more) before the series of subvertebral bones begin, on the under side of the space occupied by the notochord.

The front edge of the anterior dorsal fin (*D*) is 0.6 in. from the posterior end of the head. At least ten rays can be counted in it, but its distal end being hidden under matrix, its precise length cannot be ascertained. An interval of 0.6 in. separates the bases of the two dorsals, and so much of the second (*D*¹) as is visible, shows it to have been, as in the preceding specimen, stouter than the first dorsal. Thirty-seven neural arches can be counted in front of the point of commencement of the upper lobe of the caudal fin (*C*), the impression of which shows it to have had the ordinary *Cœlacanth* structure. The anal and ventral fins are not visible. Both pectorals (*P*) are seen, the right nearly in place. Its rays are very delicate and nearly 0.7 in. long if traced to their extreme ends. No trace of the pelvic bones, or interspinous bones, is visible.

This Cœlacanth appears to have attained much larger dimensions, as a fragmentary specimen from the same locality has neural arches 0·45 in. long, whilst those of the example described nowhere reach 0·2 inches.

A fragment of a caudal extremity of a Cœlacanth, in the same collection, leads me to suspect that a second, deeper and shorter bodied, species may have coexisted with this.

Numerous specimens sent to me by Prof. Jukes demonstrate the existence of a true *Cœlacanthus* in the Coal measures of Ballybunnion, Kerry. The largest impressions belong to fish about 12 inches long, and the fossils vary from this size to less than six inches. In none are the scales or the form of the head preserved, and hence I can give no strong opinion as to the specific distinctness of this Cœlacanth, or its identity with other species. I am inclined to think, however, that it is rather more slender than *C. lepturus*.

The Genus *HOLOPHAGUS*, Egerton.

The unique specimen upon which this genus is based is thus described by Sir Philip Egerton in a note at page 19 of the "Preliminary Essay" of the tenth Decade:—

Holophagus Gulo.

"Mr. Harrison's specimen wants the anterior portion from the dorsal and pectoral fins forwards. From the insertion of the dorsal fin to the extremity of the tail it measures $11\frac{1}{2}$ inches, and $4\frac{1}{2}$ inches in depth. The stomach is distended with a recently swallowed *Dapedius*, and a large coprolite occupies the rectum. The first dorsal fin springs (as in *Macropoma*) from a single disc, resulting from the coalescence of the interneural spines. It contains eight long, thick, undivided, and multi-articulate rays. They are beset with numerous short spines or tubercles. The second dorsal is situated 4 inches behind the first. Between the two is seen a strong bifurcate interneural ossicle, which has been displaced forwards from its proper position at the base of the fin. The second dorsal fin contains sixteen rays. The anterior ones are short and slender. The succeeding ones are long, broad, and multiarticulate, but not tuberculate. The base of the fin is obtusely lobate, with a scaly investment. The pectoral fins are much mutilated. Judging from what remains of them, and from some indistinct impressions, they seem to have been of great size. The anal fin occurs immediately below the second dorsal fin, with which it corresponds in form and structure, but contains many more rays. The ventral fins are mutilated, but their position below the first dorsal fin is indicated by the preservation of a pair of strong T-shaped pelvic bones, having their longer limbs directed forwards, and nearly reaching the base of the pectoral fins. The caudal fin is of great size, and presents in an eminent degree the most special and characteristic feature of the *Cœlacanthus* family, namely, the interposition, in the caudal region, of an interneural between the neural and dermoneural spines. The base of this spine abuts upon the extremity of the neural spine, and unites with the true fin ray by an overlap or splice. This structure coincides with that observed in *Undina*. In *Macropoma* the bone of the interneural spine is bifurcate for the reception of the distal extremity of the neurapophysis. A small supplemental fin extends an inch beyond the larger caudal fin, as in *Undina* and *Cœlacanthus*. The notochord is unossified. The apophyses, both above and below, have very wide bases. The scales are curvilinear, and covered with a vermiculate pattern on the upper surface, occasionally broken up into small tubercles."

The specimen referred to in the foregoing description is in the Museum of Practical Geology, and is figured, one-half the size of nature, in Plate VI.; with enlarged views of a scale, of anal and of caudal fin-rays. *D* is the first dorsal fin; *D*¹, the second dorsal fin; *D*¹*l*, its interspinous bone; *A*, the anal fin; *C*, the caudal fin; *C*¹, the supplemental caudal fin-rays; *Pv*, the pelvic bones.

The Genus *MACROPOMA*, Agassiz.*I. Macropoma Mantellii*, Agassiz (Plates VII. and VIII.)

Attention was first directed to this remarkable genus of *Cœlacanth* fishes, in 1822, by the late Dr. Mantell, who, at page 239 of his work "The Fossils of the South Downs," gives the following account of the specimens which had fallen under his observation:—

Amia? Lewesiensis. Tab. xxxvii., xxxviii.

"The length of this ichthyolite generally exceeds 18 inches, the head being equal to one-third of the whole; the width is about 4.5 inches. The body is of an elongated form, slightly compressed, scaly and reticulated.

The scales are of a rhomboidal shape, and beset with numerous small adpressed spines, producing a scabrous reticulated appearance, not unlike the surface of some kinds of *Balistes*. The head is angulated; the orbit large; the opercula smooth and rounded; the jaw dentated and nearly straight. The teeth in the upper maxilla are conical, pointed, and rather flat; there are about 40 on each side, of which the eight or nine anterior ones are the largest. Those of the lower jaw are exceedingly small and very numerous. The dorsal fins are two in number; the anterior one (*a*, Tab. xxxvii.) is placed in a sulcus or groove in the back, and appears to have been capable of erection or depression; it consists of eight strong rays, the two first being garnished with spines. The posterior dorsal fin (*b*, Tab. xxxvii.) is remote from the other, and composed of numerous delicate rays. The pectoral fins are placed on the thorax, near the lower margin of the opercula. The ventral fins (*c*, Tab. xxxvii.) are attached to the abdomen opposite to the anterior dorsal fin. The anal fin is unknown. The tail appears to have been rounded, but no perfect specimen of this part has been obtained. The tongue is occasionally preserved (*vide* Tab. xxix., fig. 6; Tab. xxxiv., fig. 7.) It is of a triangular form, and its surface is covered with numerous papillæ. The air bladder is of an elongated oval shape, and lies in the abdomen immediately beneath the spine."*

Dr. Mantell compares the fish with *Mugil*, *Balistes* and the *Amia ignota* of De Blainville.

In the third chapter of the second part of the second volume of the "Recherches," Agassiz established the genus *Macropoma* for the fishes discovered by Mantell; and he describes the characters of the new genus and discusses its relations in the following terms:—

"It is incontestable that this genus has striking affinities with the genus *Cœlacanthus*. The body is similarly thick, and the fins have a like arrangement. There are, as in *Cœlacanthus*, two dorsal fins, one of which lies opposite the interval between the pectorals and the ventrals, and the other opposite the space between the ventrals and the anal. The second dorsal is supported by a very strong bone, which is also found in many other genera of the family. The caudal is largely

* "It may seem scarcely credible that a part of such delicate structure should be preserved in a mineralized state, yet the fact is unquestionable. I have three specimens in my collection in which it is clearly shown."

developed, and greatly surpasses all the other fins. The scales also present a certain resemblance to those of *Cælacanthus*, in size as well as in form. But, on the other hand, the structure of the rays is very different; their cutting edges are beset with spines, and they doubtless served as protective weapons to the animal, while those of the *Cælacanthus* are smooth. The skeleton is strong, but I have not been able to satisfy myself whether the bones are hollow or not."

MACROPOMA MANTELLII, Agass.

" The head is very large; it equals more than one-fourth of the length of the body; its bones are strong, and their surface is finely dotted. In the specimen figured in Plate 65 a, the roof of the cranium, the bones which surround the orbit, the jaws, a part of the opercular apparatus, the branchial arches, and a part of the thoracic girdle are readily distinguishable in their natural relations.

" The lower jaw has a very irregular outline; its dentary edge is grooved in front, and descends towards its articulation with the os quadratum. The pterygopalatine arch is very wide, especially behind. It is the palatines and the vomer which carry the largest teeth. On the other hand, the superior maxillary, which forms the edge of the upper jaw, has none.

" The fore part of the head [*front*] is concave, and rises as a rounded projection above the orbit. The posterior suborbital is a large osseous plate, granular on its surface like the cranium; the anterior suborbitals are elongated. The operculum has its posterior edge rounded. The branchial arches are very large and strong, whilst the thoracic girdle is proportionably weak. As in the pike, this arrangement is doubtless calculated to facilitate the deglutition of a large prey.

" The scales are large, and envelope the whole body in a thick cuirass, which appears to extend very far on to the caudal, judging by the impressions observable upon the lower lobe of the tail. The surface of all the scales is granulated, and this granulation is so persistent as to be recognizable when the scale is much worn. I have represented in Plate 65 b, fig. 1, a portion of the body of a fish which I believe to be the young of the same species, and whose scales are in so perfect a state of preservation that their minute structure may be studied in detail. They have for the most part a rhomboidal form, at least they appear thus when superposed (as in nature). Isolated they present a very different form, when the root of the scale is preserved, as in fig. 3, Plate 65 b. Examined with a lens it is seen that the superficial rugosities are produced by a quantity of little elongated tubercles, or rather of small pointed cylinders, which cover all the visible part of the scales. The largest and longest are in the middle of the scale; those at the sides are shorter and more slender: the covered part of the scale is completely deprived of them; it is smooth, and exhibits only the lines of growth (Plate 65 b, fig. 3). For the rest there is no very marked difference among the scales of different parts of the body.

" I have not succeeded in discovering any trace of the lateral line; doubtless the superficial tubercles prevent the mucous canals from being recognized.

" The fins present peculiarities no less singular than those of the scales. All the rays are stiff and very stout; they do not dichotomize, and are not jointed; but on each side they are beset with a series of strong spines, turned towards the extremity of the ray. Their bases are divided into two branches, so as to form a cleft which embraces the apex of the interspinous bone. At least,

the dorsal fin rays are constructed in this manner There are two dorsal fins ; the first is situated immediately behind the pectoral girdle ; its rays are long and very strong. The second, situated opposite [*en face*] the anal (Pl. 65 a), has rays which are less robust, shorter, and more numerous, borne by a great bifurcated interspinous bone. In this specimen the fin has not fewer than 13 rays. The ventrals and the anal are nearly of equal size ; the ventrals are opposite the middle of the space comprised between the two dorsals ; the anal is rather further back than the second dorsal. Both are composed of very short, but strong rays.

"The caudal is extremely broad, and if, as everything seems to show, it is entire in the specimen (Pl. 65 a), it offers a most curious type of structure, a kind of great fan, all of whose rays appear to be equal. It is probable that it was rounded, as in certain *Sauroids*, at least no difference is observable between the upper and the lower rays. This fin is, in addition, supported in equal proportions by the superior and inferior caudal spinous processes, and the vertebral column is nowise bent upwards, as is the case in all the *inaquilobed Ganoids*. Its rays are very strong. I have counted some twenty in the lower, and a few more in the upper lobe. All are nearly equal, and only the anterior ones, situated at the base of the fin, are a little shorter. Their structure is the same as in the other fins, that is to say, the visible part of the ray is supported by a shorter ray, which is itself supported by the spinous processes of the *vertebræ*. The greater part of the caudal *vertebræ* thus afford support to the caudal fin, and it is this which gives the fin its great width.

"The internal skeleton of our *M. Mantelli* is in general robust. The apophyses are short but large, at least in the neighbourhood of the tail ; those of the abdominal *vertebræ* are longer, and bent more backward. The *vertebræ*, on the other hand, are small and delicate relatively to the size of the fish.

"But our knowledge of this remarkable fish is not limited to the skeleton ; many of the soft parts are also preserved. Among others, there are, in Mr. Mantell's collection, many specimens of the trunk in which the stomach is distinctly recognizable. (Pl. 65 c, fig. 1, and Pl. 65 d, fig. 1.) It resembles a squamose cylinder, an appearance which is evidently the result of the changes which have taken place in the different membranes which compose its walls ; vascular trunks can even be perceived. These remains are commonly accompanied by *coprolites*, which have evidently been formed in the intestine. They have a general resemblance to those of *Sauria*, and are sometimes grooved in the same way. I have represented a series of them in Plate 65 a, to show the variety of forms which they affect. It is these *coprolites* which have been described by many authors as petrified *fire-cones*." (P. 177.)

In the explanatory notes which follow Prof. Agassiz speaks of the "*bassin*," without describing it, and of the "*plaque qui tient lieu de rayons branchiostègues*."

When Professor Agassiz published his "*Monographie des Poissons Fossiles du Vieux Grès Rouge*," his views respecting the systematic position of *Macropoma* appear to have undergone considerable change. Thus he observes, at p. 61 :—

"J'ai déjà fait remarquer que le genre *Macropoma* de la craie, ainsi que le genre *Undina* de M. le Comte de Münster, cadrent mal avec les

autres Célacanthes C'est dans l'Old Red et dans l'houille que la famille des Célacanthes acquiert son plus haut degré de développement ; passé cette époque elle décline rapidement, et son dernier représentant, qui d'ailleurs est fort douteux, appartient à la craie."

In 1849 Professor W. C. Williamson gave an account of the structure of the scales and the walls of the ossified air bladder of *Macropoma* in his valuable memoir "On the Microscopic Structure of the Scales and Dermal Teeth of some Ganoid and Placoid Fishes," published in the Philosophical Transactions for that year.

Professor Williamson shows that the tubercles which ornament the scales and opercular plates of *Macropoma* are composed of layers of kosmine coated with ganoin, and resting, in the case of the operculum, upon lamellæ of bone, in that of the scales, upon a lamellar substance which contains no lacunæ, but presents layers of irregular tubes interposed between the lamellæ. Successive layers of the tubes cross one another in direction.

At the base of each tubercle, whether on the operculum, or on the scale, there is a cavity, which communicates by one or more canals with the exterior.

The walls of the structure called "air bladder" by Mantell* (who seems to have considered the solidity of the parietes of this organ to result from mineralization) and "stomach" by Agassiz, are proved by Professor Williamson to be composed of lamellæ between which are developed large lacunæ, identical with those found in the endoskeleton of the fish. Some of the external lamellæ lose their exact parallelism with those below, and one in particular assumes an undulating arrangement. On both sides of the folds of its undulations large irregular lacunæ are placed. This again is invested by other dense and apparently structureless lamellæ, which fill up the inequalities of the undulating layer, and form the external smooth surface of the organ.

With respect to the functions of this apparatus, Professor Williamson remarks:—

"I am disposed to believe that it has been an organ fulfilling the functions of an air bladder. Its osseous structure would render it capable of resisting a considerable amount of pressure ; and if its patu-

* In the Medals of Creation, 1844, Mantell gives up his first interpretation, and adopts that of Agassiz, but in "The Petrefactions and their Teachings," 1851, p. 437 he writes:—"Air Bladder (or Stomach?) of the *Macropoma*.—In every example of this fossil fish that I have dissected, there lies within the body, generally nearest the upper or dorsal part of the cavity, a long hollow cylindrical substance, often 7 inches in length, and 1½ inches in diameter, covered with a thin, brittle, scaly integument, which readily separates into two or three laminae. The anterior part of this organ, which lies close to the posterior margin of the opercular bone, is always imperfect, appearing as if torn or ruptured ; the caudal extremity terminates in a *cul-de-sac*. From the situation and structure of this viscus I supposed it to be an air bladder, and described it as such in the "Fossils of the South Downs," in 1822, but on Professor Agassiz's visit to my museum at Brighton, that eminent naturalist pronounced it to be the stomach. Recent microscopic investigations of the investing integument have, however, tended to establish the correctness of my original interpretation of the nature of this remarkable body."

lous extremity has been closed up by an elastic membranous appendage capable of acting as a valve, this would enable the creature to regulate its buoyancy, by increasing or diminishing the compression of the contained air, and thus facilitate its movements in either shallow water or at great depths. Except in cases of diseased ossification, the existence of an internal thoracic or abdominal viscus having hard parietes of true bone, is an anomaly which, as far as I am aware, has hitherto presented no parallel in nature."

Professor Williamson finally remarks that the structure of—

"The scale of *Macropoma*, as now described, is wholly different from that presented by any of the ganoid fish noticed in the preceding pages [*Lepidosteus*, *Lepidotus*, *Semionotus*, *Pholidotus*, *Ptycholepis*, *Dapedius*, *Palæoniscus*, *Gyrodus*, *Aspidorhynchus*, *Accipenser*, *Platy-somus*, *Megalichthys*, *Diplopterus*, *Holoptychius**]. It bears a much closer resemblance in its leading points to the dermal appendages found amongst the group of true Placoids, between which and the Ganoids *Macropoma* appears to form an inosculating link." (L.c. p. 464.)

In 1857, Sir Philip Egerton described and figured the specimen named *Macropoma Egertoni* by Agassiz, in the ninth of our "Decades," Pl. 10. This fossil, which was obtained from the Gault of Speeton, Yorkshire, exhibits only the anterior half of the fish, comprising the head, the pectoral fin, and the first few rays of the dorsal fin.

"The inclination of the profile line of the head is very steep from the occiput to the orbit, far more so than in the allied species; the orbit is situated in a more advanced position, and the facial line thence to the snout falls much more rapidly. The orbit in this species is large, and a portion of the capsule of the eye is preserved. The frontal bones are wide, coarse in texture, and bear a few scattered granules on their exterior surface. The borders of the upper jaw are formed of the superior maxillary bones, which are very broad; they are beset with very numerous sharp-pointed teeth, closely arranged, and of uniform size. The lower jaws are also very broad, and the space between the rami is closed by a single glossohyal plate, as in *Lophiostomus*, *Arapaima*, and *Amia*."

As regards the scales, Sir Philip Egerton remarks that—

"The surface ornament is very different; instead of the distinct tubercles so characteristic of that species (*M. Mantellii*); it is composed of minute granules united into longitudinal rows, with only a few small tubercles interspersed occasionally on some of the larger scales."

I venture to doubt that this fish belongs to the genus *Macropoma*, for the following reasons:

1°. The upper contour of the skull is quite unlike that which is seen in *Macropoma* and appears to be characteristic of the Cœlacanth in general.

2°. In no *Macropoma*, and in no Cœlacanth, however well preserved, have I seen any trace of an ossified capsule of the eyeball.

* This is not the true *Holoptychius* of the Old Red, but a distinct genus, *Rhizodopsis*.

3°. The jugular [glossohyal] plates of *Macropoma*, as of all *Cœlacanth*s, are double and not single.

4°. The shape of the lower jaw is quite different from that which is so characteristic of the same part in *Macropoma*, and the maxilla and other bones of the face are very different.

5°. The figure clearly displays several strong osseous ribs, while neither in *Macropoma*, nor in any other *Cœlacanth*, have such ribs been observed.

6°. The pectoral fin, judging by the disposition of its fin rays, does not seem to have been lobate, and the fin rays themselves appear to be articulated throughout, and not entire at their proximal ends, as in *Macropoma*.

I conceive the evidence adduced to be sufficient to prove that "*Macropoma*" *Egertoni* is not a "*Macropoma*," and indeed not a *Cœlacanth* at all. I therefore propose the generic name of *Eury-poma* (suggested to me by Sir Philip Egerton) for the fish, retaining the specific title of *Egertoni*.

In a note appended to the description of this fish, Sir Philip Egerton states that he has received from Mr. Beckles "a specimen of a "*Macropoma* found in the quarries of Purbeck stone near Swan-age. The specimen is not sufficiently perfect to determine the "species; it seems to be a shorter and deeper fish than *Macropoma* "*Mantellii*." I presume that this is the specimen to which Dr. Mantell refers (*Wonders of Geology*, p. 359).

The passages which I have quoted include, I believe, all the statements of any importance which have been published respecting the organization of *Macropoma Mantellii*. I propose to supplement the information which they contain by the following remarks upon the structure of the skeleton of this fish.

The Spinal Column.—This is as completely devoid of ossified vertebral centra as in other *Cœlacanth*s, and its structure exactly corresponds with that of the corresponding region in them (Plate VII., fig. 1).

The neural arches and spines are continuously ossified, and the former embraced the persistent notochord as in a fork. There are no bony ribs,* but the tail is provided with subvertebral bones, which closely resemble the neural arches and spines.

The Median Fins.—No specimen which I have met with shows a terminal prolongation with small fin-rays, but in other respects the caudal fin is similar to that of *Cœlacanthus* and *Undina*.

The anterior margins of the fin-rays of the median fins present

* The only specimen of *Macropoma* in which I have observed the slightest indication of ribs, is No. 25,782 in the British Museum. In this example four or five elongated bones lie on the left side and partly covered by the walls of the air bladder; but it is impossible to be certain that they may not be displaced neural spines. In *Holophagus* there are impressions of a few short rib-like bones below the posterior part of the dorsal region of the vertebral column.

near their bases a shallow groove, in which series, at first single, of rounded pits appear. In each of these pits a short pointed spine is fixed.

More towards the distal end of the fin-ray the rows of pits and spines become double, those of the two sides usually alternating. In no specimen I have met with does a fin-ray present any indubitable articulation. It is probable that the extreme ends were articulated, but the length of unjointed fin-ray is remarkable in *Macropoma*, as compared with *Holophagus* and *Cœlacanthus*.

The first dorsal fin is supported by the single lamellar interspinous bone (Plate VII., fig. 1), which is as characteristic of the *Cœlacanth*s, as the forked interspinous bone of the second dorsal (Plate VII., fig. 1), indicated by Agassiz. The true form of the first dorsal bone is best exhibited in No. 4,260 of the British Museum, which shows it to be plough-share shaped, the anterior margin being oblique, and much longer than the posterior. Several ridges radiate from its upper edge downwards and forwards to its anterior inferior angle and inferior edge.

The Pectoral and Ventral Fins.—The pectoral fins are supported by a very strong bone, curved so as to be concave forwards, flattened from side to side, and giving off a process upwards and backwards, so as to appear bifurcated above. (Pl. VII., fig. 4 b.)

The ventral end of each pectoral arch widens out in a direction transverse to the axis of the body, and becomes concave from side to side behind, so that this part of the bone takes on much the appearance of a marrow spoon. This is particularly well seen in No. 4,251 of the British Museum Collection.

I have met with only one specimen of the chalk *Macropoma* which shows the structure of the pectoral fin distinctly. In this (Coll. British Museum, 4,258) the right pectoral is thrown forward, and seen from the inner side (Plate VII., fig. 5). The rays, about 20 in number, decrease in strength from before backwards, and their inner ends are so arranged as to show that they fringed an obtuse lobe. On this no trace of scales was discernible, but the left pectoral, which is imperfectly preserved, shows the remains of a covering of small scales with a tuberculated ornamentation.

The pelvic bones are very long, and each has, at its base, a strong process directed at right angles to the axis of the bone, and meeting its fellow of the opposite side (Plate VII., fig. 1).

There is a specimen showing a ventral fin in the British Museum (No. 25,944), in which the fin-rays are so disposed as to lead me to believe that it was lobate.

The fin-rays of the paired fins do not seem to have possessed the spinous ornamentation along their anterior edges, which is seen in the median fins.

The Skull.—The roof of the skull (Plates VII., fig. 1, VIII., fig. 2), is divisible in *Macropoma*, as in *Cœlacanthus*, into two moieties, an anterior or frontal (B), and a posterior or occipito-

parietal (A) which meet at an obtuse angle, the occipito-parietal moiety being nearly parallel with the base of the skull, while the frontal slopes obliquely forwards and downwards to the snout; the occipito-parietal portion is slightly convex from before backwards, and more so from side to side; while the frontal portion, though convex from side to side, is slightly concave from before backwards.

Viewed from above, the occipito-parietal shield (A, fig. 2, Pl. VIII.) has a trapezoidal form, being more than twice as wide behind as in front, in consequence of the production of its posterolateral angles. A median sutural line distinguishes it into two halves; and, in the specimen represented in fig. 1., Pl. VIII., what appears to be a true suture runs obliquely from the median suture outwards and forwards to the outer margin of the parieto-occipital shield, cutting off a large triangular plate of bone, which appears to represent the so-called "*squamosal*" and the *suprascapular* (*S. Sc.*) of ordinary fishes from the proper parietals (*Pa.*)

The sculpture of this part of the roof of the skull presents the form of reticulated ridges and grooves, directed more or less transversely, with interspersed dots and splashes of enamel.

The frontal shield (B, fig. 2, Pl. VIII.), similarly viewed from above, is rounded in front, somewhat constricted in the interorbital region, and truncated behind, where it joins the parietals.

Like the posterior shield, it is divided by a median longitudinal suture, and in the specimen figured in Pl. VIII. it presents indications of the existence of a transverse dentated suture at its most constricted part.

In the same specimen, which is perhaps young, the proper frontal bones appear to be very narrow, the outer third of each being formed by a fringe of apparently distinct marginal ossicles (*x*); but these seem, eventually, to become completely united with one another, and with the frontals. The surface of the frontal shield exhibits a pitted and reticulated sculpture, like that of the occipito-parietal, which is most distinct on the marginal ossicles. The dots of enamel are scanty, and scattered at wide intervals.

The *basis cranii* (*a*, *b*, *c*) is formed by a layer of bone, which is continuous, and presents no trace of sutures, between *a* and *b*. Behind *b* it is defective for some distance, but reappears in front of *c*. It doubtless represents, in the greater part if not the whole of its extent, the *parasphenoid* of ordinary fishes.

Between the orbits this *parasphenoid* has the form of a stout bar of bone, grooved above, convex and smooth below; but it becomes flattened out from above downwards, both anteriorly and posteriorly. Anteriorly, it ends as a spatulate plate (Plate VIII., fig. 3*a*), which has prominent lateral margins, bounding a transversely concave under surface, over which are scattered multitudes of minute granular teeth, those on the margins of the plate being somewhat larger than the rest. The dentigerous plate may represent a vomer, but in no specimen that I have seen can it be distinguished from the *parasphenoid*.

Posteriorly, the parasphenoid is broken, but probably passed into the flat bony floor of the parieto-occipital division of the skull, which may either be an extension backward of the parasphenoid, such as exists in the sturgeon, or may be formed by coalescence of the latter with a true basi-occipital.

Above its spatulate dentigerous part, the basal bone passes upwards and outwards into strong lateral plates (Plate VIII., fig. 1, *Pr. f.*), which are concave outwards, and unite with the frontal shield. They represent the *prefrontals*.

Each prefrontal gives off from its anterior end, just above the rounded extremity of the dentigerous plate, a stout process (Plates VII., fig. 6, VIII., figs. 1 and 3, *d*), which passes downwards and outwards, and ends by a free rounded extremity at the margin of the gape, close to the anterior end of the maxilla. This appears to represent the process of the prefrontal bone with which the palatine articulates in ordinary fishes.

The interorbital space above the parasphenoid, from the posterior margins of the prefrontals as far as a point a little in advance of the junction of the fronto-nasal and parieto-occipital shields, seems to have been devoid of ossifications answering to the orbitosphenoids and alisphenoids; but further back the sides of the parasphenoid pass indistinguishably into the *pro-otic* bones. Each of these is a large plate of bone, rising perpendicularly towards the roof of the skull, which it nearly reaches in front. Further back it sends out two great processes, one superior and the other inferior, at right angles to its own plane.

The superior process (Plate VIII., fig. 1, *e*), curving outwards abuts against the under surface of the occipito-parietal shield, close to the middle of its outer margin, and furnishes an articular facet for the proximal end of the hyomandibular bone (Plate VIII., fig. 2, *H.M.*).

The superior process of the pro-otic is separated by a deep oval fossa from the inferior process (Plate VIII., figs. 1 and 2, *f*), which is a stout plate of bone, convex from above downwards on its outer surface, and ending in front by a free thick edge, represented somewhat too round in Pl. VIII., fig. 2. The lower incurved edge of this scroll-like plate does not come into contact with the osseous basis cranii, which hereabouts begins to be defective.

The root of the superior process (Pl. VIII., fig. 1 *e*) separates two slit-like foramina which lead into the interior of the skull, and probably gave exit to divisions of the fifth nerve. From the upper and external edge of the inferior process a vertical bar of bone is sent off and, abutting against the superior process, bounds an oval fossa behind.

Externally and posteriorly, the pro-otic abuts, by an abruptly truncated and perpendicular face, against another stout lateral osseous mass (*g*), which appears to represent the *opisthotic* and *exoccipital*. From this three processes pass, one ascending, which lies against the vertical bar (*f*¹) of the pro-otic; a second external and ascending process (Pl. VIII., figs. 1 and 4, *h*,) passes upwards and backwards to unite with and support the supra-scapular part (*S. Sc.*) of the parieto-occipital shield. The third process (Pl. VIII., figs. 1 and 4, *i*) is

directed outwards from near the base of the skull (perhaps arising chiefly from the parasphenoid), and ends in a free obtuse surface, against which the middle of the hyomandibular suspensorium abuts (Pl. VIII., fig. 2). Behind the part from which these processes are given off, the opisthotic and exoccipital ossification is continued backwards as a vertical plate, which forms a large part of the postero-lateral walls of the cranial cavity. Between this plate and the processes of the opisthotic there is a deep fossa, floored below by a thin plate of bone (Pl. VIII., fig. 4 *k*) which forms a sort of continuation of the lower edge of the third process of the opisthotic (*i*) into the base of the skull.

The lateral "exoccipital and opisthotic" plates do not reach the roof of the skull superiorly, but end in a free edge, posteriorly; they diminish to a height of not more than one-eighth of an inch above the base of the skull. From the point where it is lowest (Pl. VIII., fig. 4 *l*) the base of the skull rapidly diminishes in breadth, and ends at *c*, by a free rounded extremity, which is so fractured that its precise shape is not determinable.

A thin plate of bone (Pl. VIII., fig. 4 *m*) forms a low arch over this part of the skull, and is continuous with the basal plate below.

It is not improbable that this arch may represent an anterior vertebra corresponding with one of those which, in the *Ganoidei*, commonly coalesce with the occipital region of the skull.

The pro-otic bones of opposite sides are not separated by a greater distance than the width of the presphenoidal bone in front and below, but, above, they are somewhat more distant.

The anterior end of the snout of *Macropoma* is constituted by a single bone having the form of a triangle with its base downwards, with a convex anterior and concave posterior surface (Plate VII., figs. 3, 4, and 6). The convex face is beset with small cylindrical teeth, but at the postero-lateral angles of the oral, or lower, margin of the plate, several larger curved and pointed teeth are attached.

The posterior concave face is smooth, and seems to have played over the ethmoidal cartilage.

This bone may either represent the *premaxillæ* coalesced, which is the interpretation that first suggests itself; or, on the other hand, it may be a *vomer*, such as would be formed if the vomerine teeth of *Lepidosiren* were supported upon a common bony base. In the latter case the *premaxillæ* remain to be discovered.

The hyomandibular, quadrate and pterygoid elements of the face are represented in *Macropoma* by a great triangular plate of bone, in which I have not been able to discover any distinct sutures. The outer and upper surface of this "pterygo-suspensorial" bone, and its general form, are well shown in fig. 3., Pl. VII., while the proper contour of the hinder half of its lower edge is seen in fig. 6 of the same plate. The inner surface of an entire pterygo-suspensorial bone is beautifully displayed in No. 4246 of the British Museum collection.

The whole plate is so twisted upon itself that, anteriorly, its surfaces look almost downwards and upwards, while posteriorly, they look inwards and outwards. The anterior angle is compara-

tively thin and rounded off, and extends forwards to the level of the prefrontals (Pl. VII., fig. 3; Pl. VIII., fig. 3), where it articulates with the bone, *Pl.*, which it underlies.

The posterior inferior angle is formed by a very stout neck which bears the transversely elongated condyle for articulation with the mandible. This condyle has a subcylindrical pulley-shaped articular surface, somewhat excavated in the middle, like the distal end of a humerus.

The upper and posterior angle of the bone, *H. M.* is likewise formed by a strong neck, which expands above into a broad head, and articulates thereby with the side walls and roof of the skull (Pl. VIII., fig. 2).

The outer and upper surface of this bone is remarkably smooth and polished. The inner surface, on the contrary, with the exception of a small strip belonging to the posterior part of the quadrate, is evenly covered with minute asperities, which have, for the most part, more the aspect of tubercles of enamel than of teeth. Along the outer edge, however, they become longer, sharper, and more tooth-like.

In Pl. VIII., fig. 3, the anterior end of the left pterygo-suspensorial bone is seen to pass to the ventral side of, and become connected with, the bone *Pl.*, which is convex from side to side below, and correspondingly concave above. The inner edge of this bone articulates with the prefrontal, and I conceive that it represents the *palatine*.

The concave upper surface of the right palatine is well seen in No. 4241 in the British Museum; and here again the bone is connected on the inner side with the prefrontal, and on the outer, with the anterior end of the pterygo-suspensorial. In the specimen represented in Pl. VIII., fig. 3, there are no teeth upon the oral surface of either of these bones; but I believe that such teeth existed, inasmuch as No. 4237 B.M., the head of which is represented in fig. 3, Pl. VII., shows, in the interior of the mouth, a convex plate, *Pl.*, covered with small teeth. In this specimen and in No. 4252 B.M. (Pl. VII., fig. 6) certain sharp, curved, conical teeth, *bb*, are visible, which certainly belong neither to the maxilla nor to the bone *x*, and may have been attached to the palatines.

The *Maxillæ* (Pl. VII., fig. 6; Pl. VIII., figs. 2 and 3) are slender bones which lie alongside the outer margin of the pterygo-suspensorial bone, and form the edge of the gape. Their lower edges are beset with small curved teeth. Their anterior connexions are not displayed in any specimen I have seen. Posteriorly, each abuts upon the apex of an elongated triangular "postmaxillary" bone which fills up the interval between the suborbitals, opercula, and mandible, and covers the quadrate articulation.

Each ramus of the mandible is very stout, and is deepest in the middle third of its length (Pl. VII., fig. 6), where its upper margin is nearly straight. Posteriorly, the upper margin diminishes in height rather gradually; but, anteriorly, it falls rapidly, being as it were excavated towards the symphysis.

In the mandibles, which are represented in Pl. VII., the greater part of the angular-articular and dentary elements have been broken away leaving only the plate which answers to the splenial of reptiles (fig. 3., *Spl.*) And it is this plate which gives rise to the height and straightness of the upper edge of the middle third of the ramus.

The angulo-articular element of the mandible, which forms the outer part, if not the whole, of the ramus at the articulation, rapidly diminishes in height, and leaves the outer surface of the splenial bare as it passes forwards. It then meets the dentary, fitting into a V-shaped space afforded by the latter.

The dentary, passing forwards, suddenly rises into a kind of shoulder, *y* (fig. 4, Pl. VII.), which applies itself to the anterior part of the outer surface of the splenial.

In uninjured specimens the whole outer surface of the angulo-articular is covered with tubercles of enamel. Similar, but more scattered, tubercles ornament the dentary; but the outer surface of the splenial, exposed between the process *y* and the front and upper margin of the angular-articular, is perfectly smooth.

There is a distinct suborbital half ring (Pl. VII., fig. 1), formed to all appearance of a single bone, or of several bones which have coalesced, and presenting a granular external sculpture. The posterior part of the suborbital ring is much broader than the anterior, and abuts upon the operculum, behind and below which it comes into contact with the triangular postmaxillary bone: in front and above it, exhibits a deep notch.

The ornamentation of the suborbital bones consists of pits and reticulated ridges, with scattered tubercles of enamel.

The *operculum* (Pl. VII., fig. 1, *op.*), is a large four-sided bone. Its upper margin is shortest; its front margin, which is as long as the distance from the roof of the skull to the lower edge of the triangular "post-maxillary" bone, longest. The posterior margin is much shorter, so that the lower edge of the operculum runs very obliquely, from above and behind downwards and forwards.

Traces of a *suboperculum*, much smaller than the operculum, are discoverable in some specimens.

When the outer surface of the operculum is complete, it is covered with close-set conical enamel tubercles, like those of the roof bones of the cranium.

Two large *jugular plates* occupy the whole interval* between the rami of the mandible. The inner, opposed, margins of these plates are straight, the outer, evenly convex.

The *hyoidean arch* is strong and well ossified, and is connected with the hyomandibular by a very strong "*stylo-hyal*" (*St. h.*, figs. 3 and 6, Pl. VII.).

Each *branchial arch* is, apparently, a single arcuated bone, deeply grooved posteriorly. I can count only four on each side in the

* In No. 25,872, of the British Museum Collection, the surface of the jugular plates is perfectly preserved, and is ornamented with tubercles of enamel, which are set, evenly, and pretty close together, over its whole surface.

specimen (belonging to the Earl of Enniskillen), which best displays these structures.

The resemblance of the branchial apparatus of *Macropoma* to that of *Cœlacanthus* is still further increased by the large spatulate bone, which, in *Macropoma*, terminates the median part of the branchial skeleton posteriorly. No specimen has exhibited the anterior moiety of the median branchial skeleton, so that I am unable to say whether it has or has not the form of a crucial bone.

I have not been able to procure detached teeth of *Macropoma* for microscopic examination. The bases of even the largest teeth are perfectly smooth, and present no longitudinal grooves or foldings.

Macropoma substriolatum, Huxley (Plate IX. and X.).

I have abstained hitherto from referring to a specimen of a fossil fish to which Sir Philip Egerton refers in the following terms, in the note at p. 19 the "Preliminary Essay" of Decade X.:—

"In the Woodwardian Museum, at Cambridge, there is the head and part of the trunk of a *Cœlacanthus*, from the Kimmeridge clay at Cottenham. The head shows the frontals, prefrontals, and lower jaw, with the tympanic attachments. The glossohyal plate is double, as in *Holoptychius*. The scales are roughly undulate, coarser in pattern than in *Undina*, *Cœlacanthus*, and *Holophagus*, but not absolutely tuberculate, as in *Macropoma*. One fin is preserved, probably the left pectoral. It is lobate, broad, and strong. The operculum is triangular, the frontals short, and the prefrontals descend at an abrupt inclination."

Pl. IX. represents the ventral surface of the body of the *Cœlacanth* fish of which Sir Philip Egerton speaks, of the size of nature.

It is covered with large, thin, cycloidal scales, each of which is divided into a large smooth region, overlapped in front and on each side by the neighbouring scales, and a comparatively small free part, which presents numerous close-set elongated dots, or short ridges, of enamel. The dots and ridges are distinct, and their long axes are roughly parallel with that of the body, though the lateral ones sometimes show a certain tendency to diverge from the long axis of the scale itself.

The left pectoral fin (*P*) is very well shown, and exhibits, at fewest, fifteen fin-rays, the bases of which are so disposed as to inclose an oval "lobe," which is completely covered by small scales, not more than half, or a third, as large as those of the body, but possessing the same ornamentation.

The proximal ends of the fin-rays are unarticulated, but seem to be hollow; distally they become broader and flatter, and then narrow to points, without becoming longitudinally subdivided. Rather more than the distal half of each, apparently, was divided, transversely, into short broad joints.

The surfaces of these fin rays are quite smooth.

Four views (one-half the size of nature) of the head of this fish are given in Pl. X.; it is composed of a parieto-occipital and a frontal moiety, as in *Macropoma*, and the former (*Pa*) is divided by a median suture into two. The frontal shield is greatly crushed, and its precise form cannot be made out, but so much of it as remains is like that of *Macropoma*.

The general arrangement of the suborbital bone or bones (figs. 2 and 3) is plainly similar to that in *Macropoma*; and the same likeness extends to the operculum (*Op*), to the strong pulley-like end of the quadrate (*Qu*),—divided in the present fish by a longitudinal depression, so as to resemble the articular end of a phalanx,—and to the lower jaw.

I suspect that *b*, fig. 2, represents the *post-maxillary* bone of the Chalk *Macropoma*, in which case the flat bone *a* (figs 2 and 3) will probably be the *suboperculum*.

The jugular bones (fig. 4, *G*) are double, and closely resemble those of *Macropoma* in form: they present an ill-defined rugosity, but no proper sculpture, and no trace of enamel, resembling in this respect the opercula and the other bones of the head.

At *a*, fig. 4, clear traces of ossified branchial arches are visible.

In its general characters it is clear that this fish completely resembles *Macropoma*; and considering the frequency with which the enamel is found to have disappeared from the cranial bones of fishes of the latter genus in the Chalk, no weight can, I think, be attached to this apparent difference.

The scales are quite similar to those of *Macropoma* in form, and in the proportion of the sculptured to the unsculptured part (the unsculptured part in the scale 3 of plate 65 *b* of the "Recherches" is far too small), but the enamel tubercles are far less regularly oval, and tend to become elongated and ridge-like.

I think, therefore, that this may safely be regarded as a distinct species, for which I propose the name of *Macropoma substriolatum*.

I am indebted to Prof. Sedgwick and Mr. H. Seely, for the opportunity of figuring and describing the specimen on which this species is based.

The common characters, classification, and distribution of the
CÆLACANTHINI.

The fossil fishes which have been described above under the names of *Cœlacanthus*, *Undina*, *Holophagus*, and *Macropoma*, have the following characters in common :—

1. The body is covered with thin cycloidal scales, the exposed portion of which is ornamented with tubercles or ridges of enamel.

2. There are two dorsal fins, the anterior supported by a single broad and plate-like interspinous bone; while the posterior has a forked interspinous bone. There is a single anal fin, and a very large caudal, the upper and lower lobes of which are equal; the spinal column, which traverses it without being at all bent up, ending in a filament with small supplementary fin rays.*

In the caudal fin, interspinous bones are interposed between the fin-rays and the neural and subvertebral spines.

3. The paired fins are obtusely lobate. The pectoral arch is strong and well ossified, and there are two large pelvic bones. The fin-rays of all the fins are not articulated at their proximal ends, and are longitudinally undivided. The ventral fins are placed but very little behind the anterior dorsal, and the anal lies below the posterior dorsal.

4. The spinal column is unossified, the notochord being persistent, and only the neural and subvertebral arches ossified. If ribs existed at all, they were remarkably small.

5. The roof of the skull is formed by a parieto-occipital and a frontal shield, which meet at an obtuse angle. The surface of each of these is ornamented with tubercles of enamel.

6. There is a large "pterygo-suspensorial" bone representing the hyomandibular, quadrate, and pterygoid bones of ordinary fishes.

7. There are two jugular bones and no proper branchiostegal rays.

8. The branchial and hyoidean arches are well ossified, and there is a median bone in the branchial series which has a spatulate posterior termination (not observed in *Holophagus* and *Undina*).

9. The air bladder has ossified walls.

10. The teeth are for the most part "en brosse" or tubercle-like and minute; but a few are larger, acutely pointed (*Undina*? *Holophagus*?). These larger teeth exhibit no plications at their bases.

These being the common characters of the *Cœlacanthini*, the next point is to obtain clear definitions of the several genera which compose the group.

Cœlacanthus is readily enough distinguished from the rest by

* This peculiarity of the caudal fin has not not been actually observed in *Macropoma*; but it is hardly doubtful that the cretaceous genus resembled the others in this particular.

the ornamentation of its scales, which is disposed in converging ridges, not in tubercles; by the ridged ornamentation of the rami of the mandible and of the jugular bones; and by the absence of spines upon the fin-rays of the median fins.

In *Macropoma*, on the other hand, the scale ornament is made up of distinct tubercles; the jugular bones and mandibular rami are covered with tubercles, not with ridges; there are single or double rows of stout spines upon the anterior edges of the fin-rays of the median fins, which are inarticulated through the greater part of their length.

In *Holophagus* the scale ornament is in ridges, like that of *Cælacanthus*. There are small spines, sometimes in more than two rows, upon the fin rays of the anterior dorsal and both lobes of the caudal fins; but I see none upon the second dorsal or upon the anal. The median fin-rays are articulated through more than half their length.

Of the two species of *Cælacanthus* (= *Undina*) described by Count Münster, *C. Kohleri* is distinguished by the ornamentation of its scales "resembling flies' eggs," and by the rows of small spines upon the fin rays of the first dorsal and caudal fins.

The beautiful specimen of this species, the property of the Earl of Enniskillen, which is before me, shows the first and second dorsal fins, the pectorals, and the ventrals; the tail is wanting. The fin-rays of the anterior dorsal are spinous, and the spines are set in a double row along the anterior edges of the fin-rays, much as in *Macropoma*, and unlike *Holophagus*. The fin-rays remain undivided much further from their base than in *Holophagus*, and in this respect, also, more resemble *Macropoma*.

The sculpture has disappeared from the cranial bones, and the inner sides of the two jugular bones are exposed, so that nothing can be said upon this point. The scales are represented by mere bony films.

The head is altogether similar in form to that of *Macropoma*. There is a well ossified parasphenoid. The stylohyal, the operculum, the pectoral arch, and the lower jaw, so far as they are preserved, are very like those of *Macropoma*.

The only teeth which are visible are small and granular, and resemble those of the pterygo-suspensorial and parasphenoid bones in *Macropoma*. The absence of pointed teeth is a circumstance of merely negative import, to which I am not disposed to attach any importance.

Of *Cælacanthus* (*Undina*) *striolaris* I have seen no specimen, but while Münster's figures show that, in all important respects, it resembled *C. Kohleri*—he assigns to it scales with a striated ornamentation, and fin-rays without spinous ornamentation. Putting aside the teeth (the absence of sharp teeth in *Undina* and of granular teeth in *Cælacanthus* not being proved), I see no character by which this species is separable from *Cælacanthus*, while *C. Kohleri* appears to be equally indistinguishable from *Macropoma*.

If this supposition should be borne out by the examination of more perfect specimens of *Undina*, the genera of Cœlacanthus would be reduced to three,—*Cœlacanthus*, *Holophagus*, and *Macropoma*; and, in the ornamentation of its scales and fin-rays, *Holophagus* would occupy the same intermediate position between the other two genera as it does in time. However, it is better, for the present, to retain *Undina* as a distinct genus.

Bearing in mind the range of the Cœlacanthus from the Carboniferous to the Chalk formations inclusive, the uniformity of organization of the group appears to be something wonderful.

I have no evidence as to the structure of the base and side walls of the skull in *Cœlacanthus*, but the data collected together in the present Decade show that, in every other particular save the ornamentation of the fin-rays and scales, the organization of the Cœlacanthus has remained stationary from their first recorded appearance to their exit. They are remarkable examples of what I have elsewhere termed “persistent types,” and, like the Labyrinthodonts, assist in bridging over the gap between the Palæozoic and the Mesozoic Faunæ.

DESCRIPTION OF PLATES—II. to X.

PLATE II.

- Fig. 1. A specimen of *Celacanthus lepturus*, of the natural size. In the Museum of Practical Geology.
 Fig. 2. The anterior part of the body enlarged.
 Figs. 3, 4. Scales magnified.

PLATE III.

- Fig. 1. *Celacanthus lepturus*, of the natural size.
 Fig. 1a. Scales magnified.
 Fig. 1b. Part of the ornamentation of the operculum magnified.
 Fig. 2. The hinder part of the body of a *Celacanthus lepturus*, of the natural size, showing the remains of the ossified air-bladder.
 Fig. 3. Under view of the head of a *Celacanthus lepturus*.
 All these specimens are in the Museum of Practical Geology.

PLATE IV.

- Fig. 1. Magnified view of the counterpart of the specimen represented in Plate III., fig. 3.
 Fig. 2. The mandible of the same inverted.
 Fig. 3. Under view of the head of a specimen in the collection of Edw. Binney, Esq., F.R.S.
 Fig. 4. Pelvic bones of *Celacanthus lepturus*. In the Museum of Practical Geology.
 Fig. 5. The two dorsal fins of a *Celacanthus lepturus*. In the Museum of Practical Geology.
 Fig. 6. Caudal extremity of a specimen of *Celacanthus lepturus*. Magnified $1\frac{1}{2}$ times.

PLATE V.

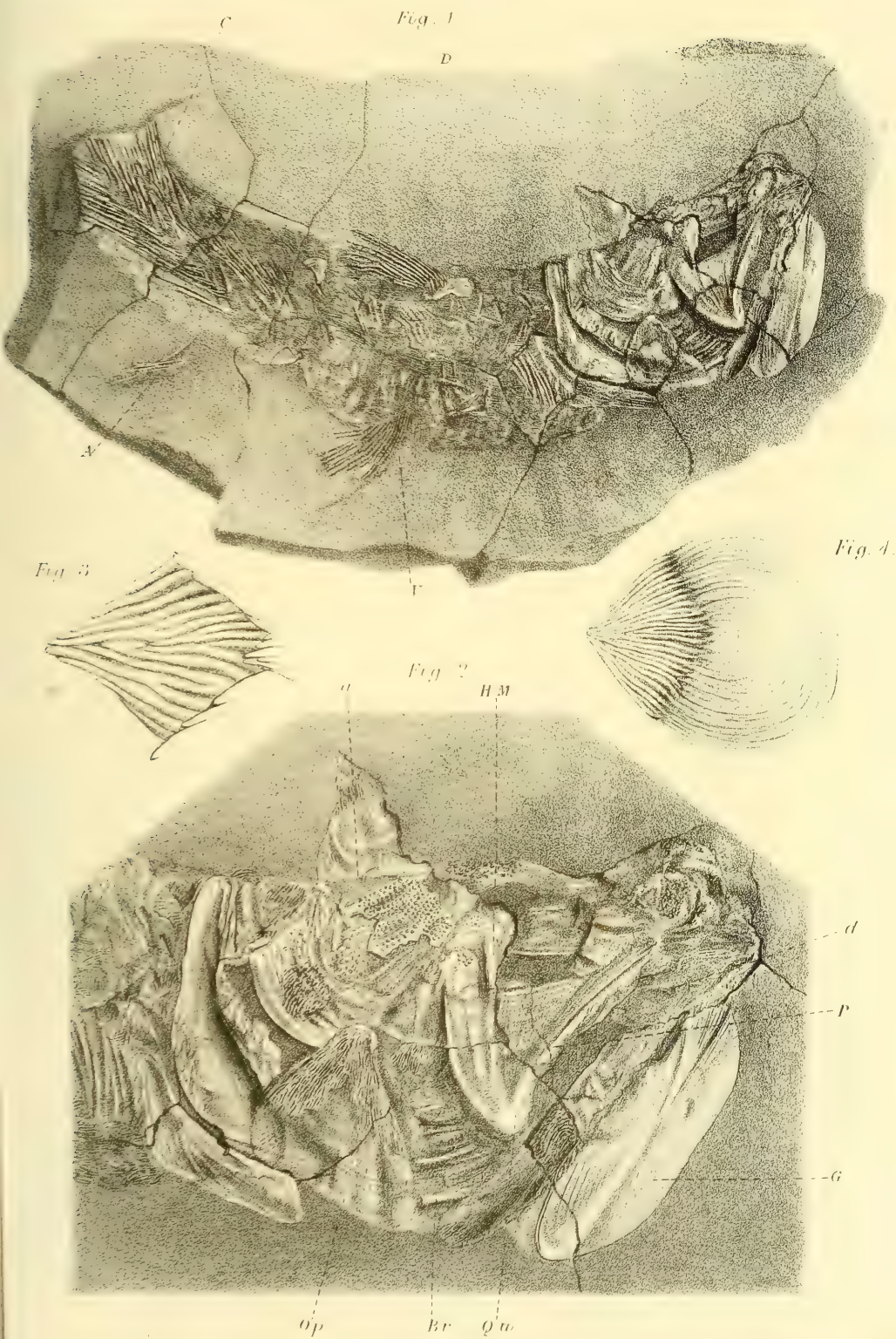
- Figs. 1, 2, 3, 4. *Celacanthus elegans*. From specimens in the collection of Sir Philip Egerton, Bart.
 Fig. 5. *Celacanthus caudalis*. In the collection of Sir Philip Egerton, Bart.
 Figs. 5, 6. *Celacanthus elongatus*. In the Museum of the Geological Survey in Ireland.

PLATE VI.

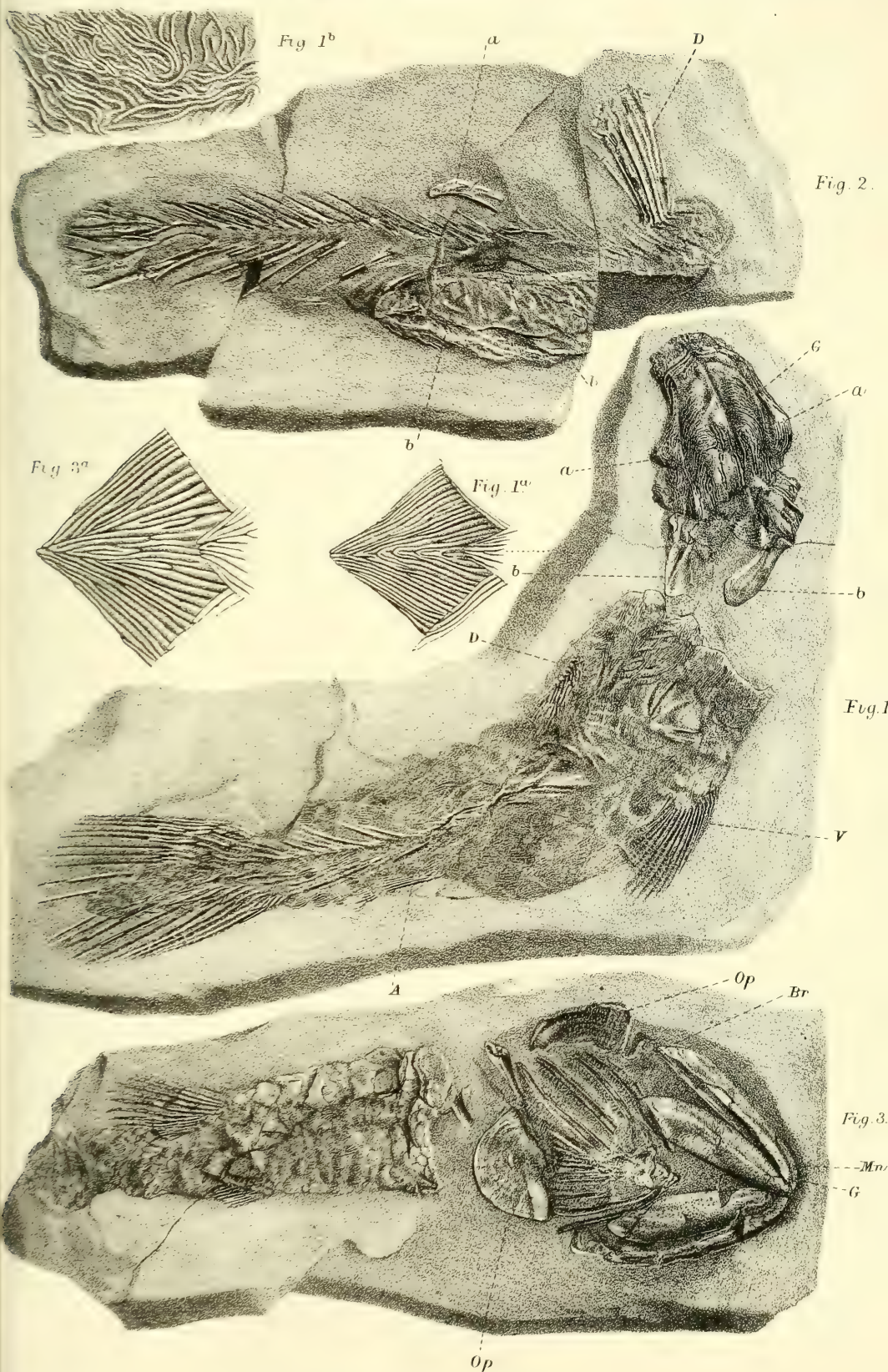
Holophagus gulo, with a scale and fin-rays magnified. In the Museum of Practical Geology.

PLATE VII.

- Fig. 1. *Macropoma Mantellii*. One half the size of nature. In the Museum of Practical Geology.
 Fig. 2. A detached air-bladder of *Macropoma Mantellii*. One-half the size of nature. In the British Museum.
 Fig. 3. The head of *Macropoma Mantellii* figured by Prof. Agassiz, 'Recherches' II, Pl. 65 d, fig. 2, the matrix having been further cleared away.
 Fig. 3a. The teeth enlarged. In the British Museum (No. 4237).
 Fig. 4. A side view of the snout of the *Macropoma Mantellii*. Figured by Prof. Agassiz, l.c. Fig. 1. In the British Museum (No. 4,270).
 Fig. 4a. Front view of the dentigerous "premaxillary" bone. Magnified.
 Fig. 4b. The upper end of the pectoral arch of this specimen.
 Fig. 5. A pectoral fin of a *Macropoma Mantellii*. In the British Museum (No. 4,258).
 Fig. 6. The head of a *Macropoma Mantellii*. Figured by Prof. Agassiz, l.c. Fig. 3. In the British Museum (No. 4,252).



Calacanthus lepturus (Agassiz.)



Celacanthus lepturus (Agassiz.)



Fig. 1.

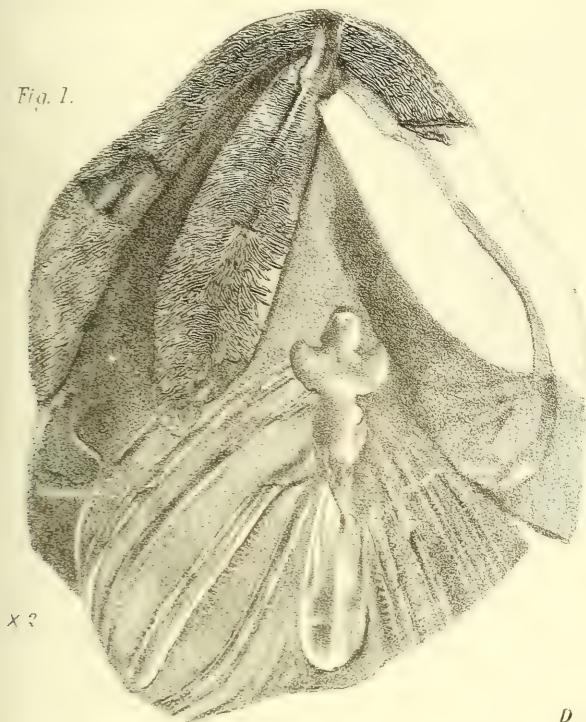


Fig. 3.

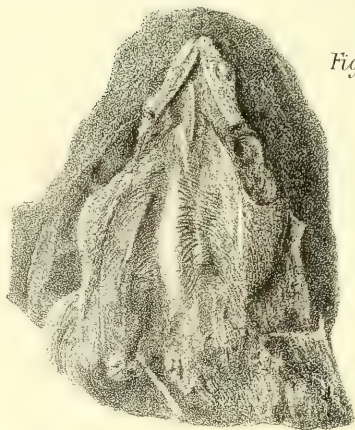


Fig. 4.

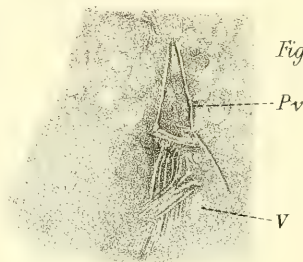


Fig. 2.



Fig. 5.



Fig. 6.

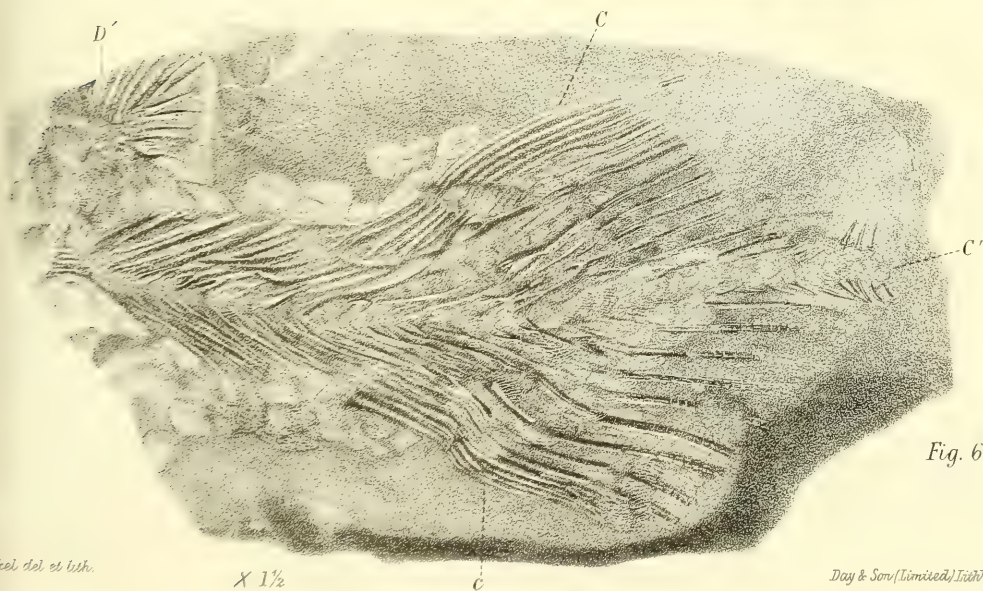


Fig. 1.

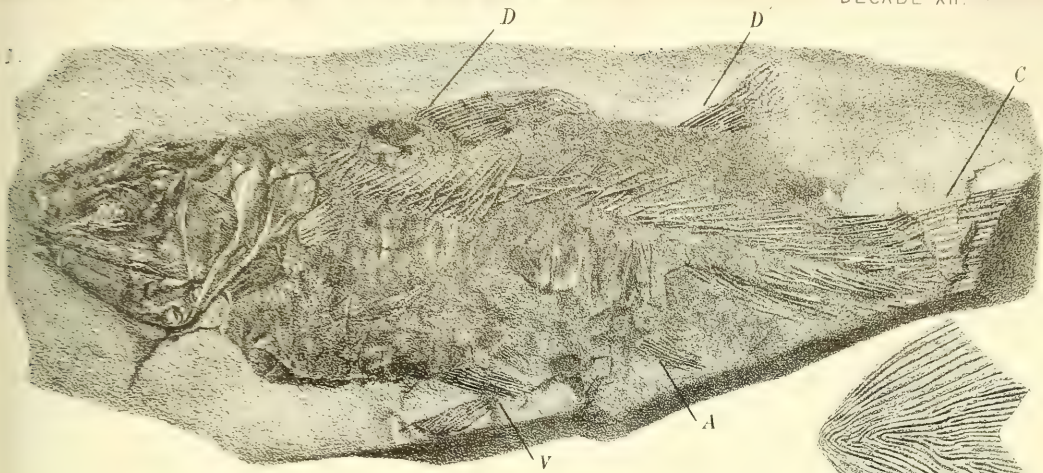


Fig. 4.

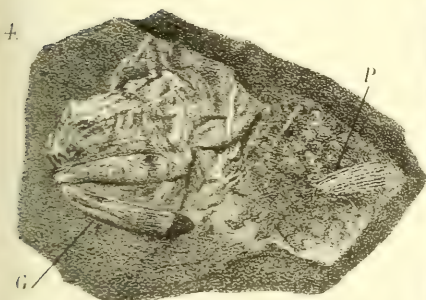


Fig. 2.

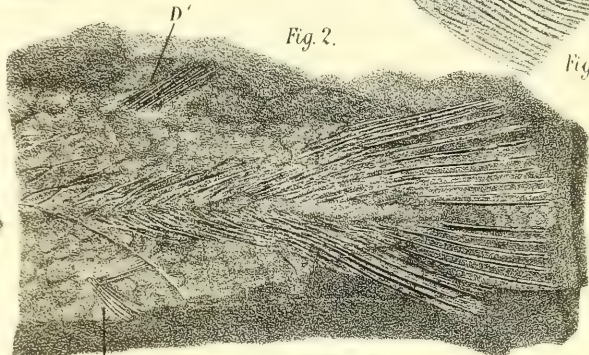


Fig. 3.



Fig. 5.

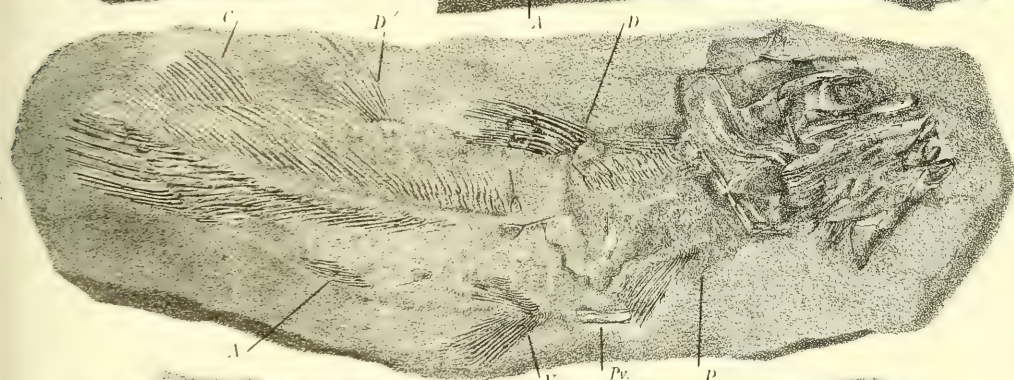


Fig. 6.

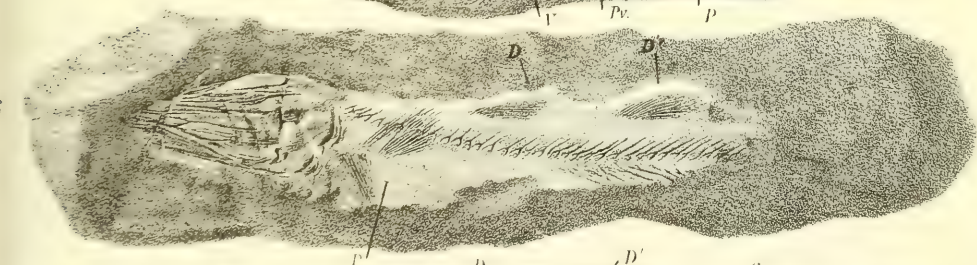
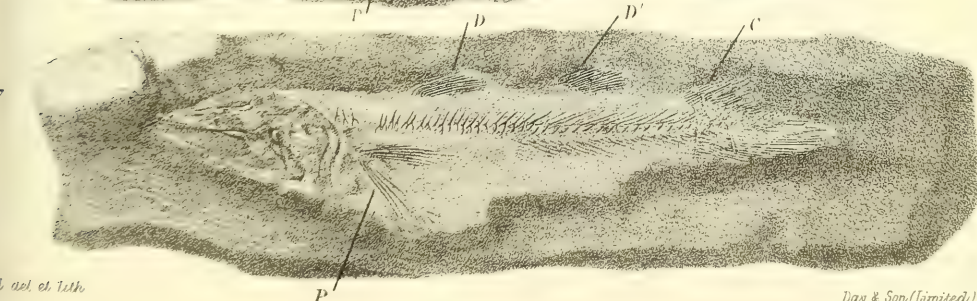


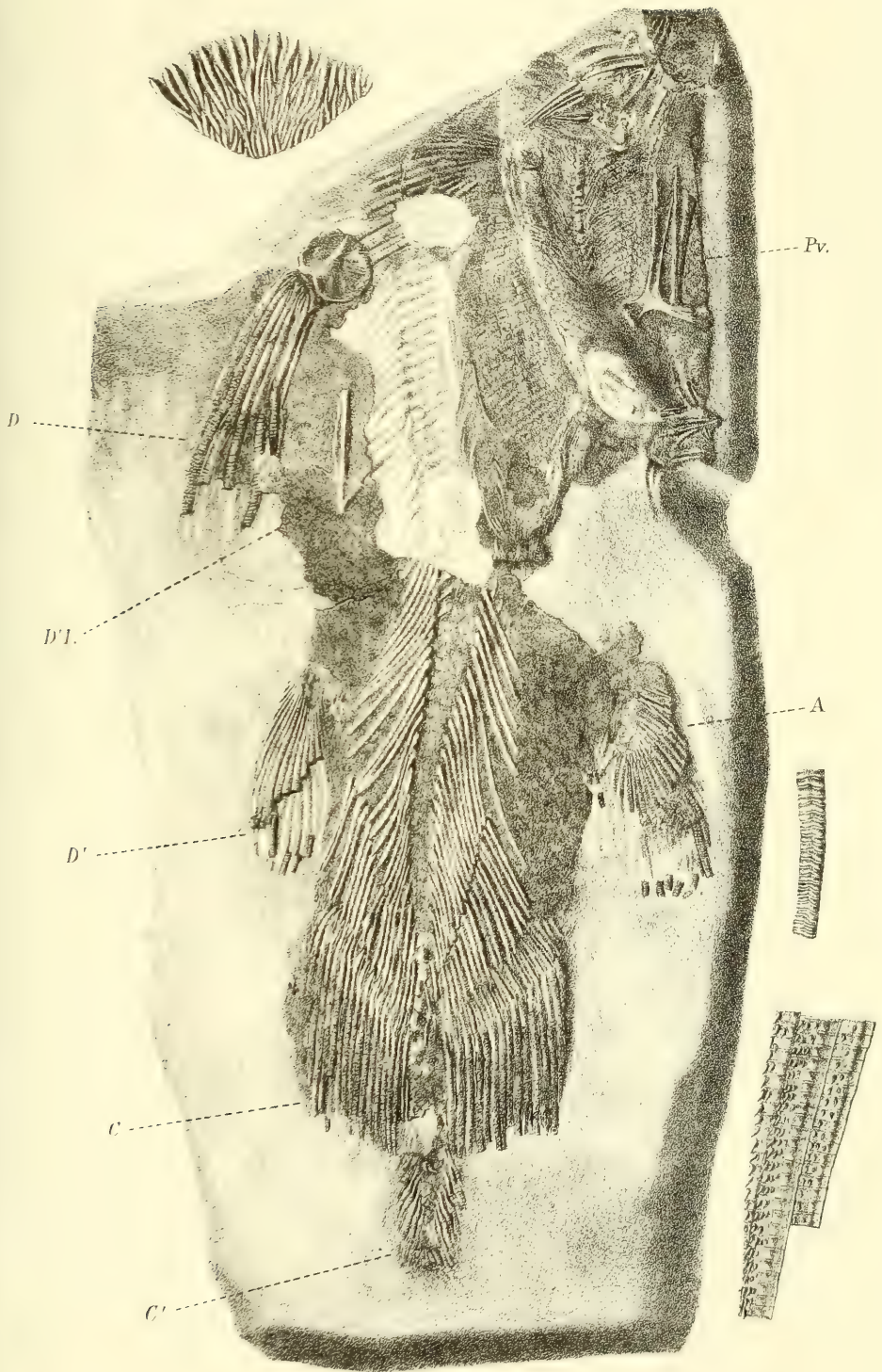
Fig. 7.



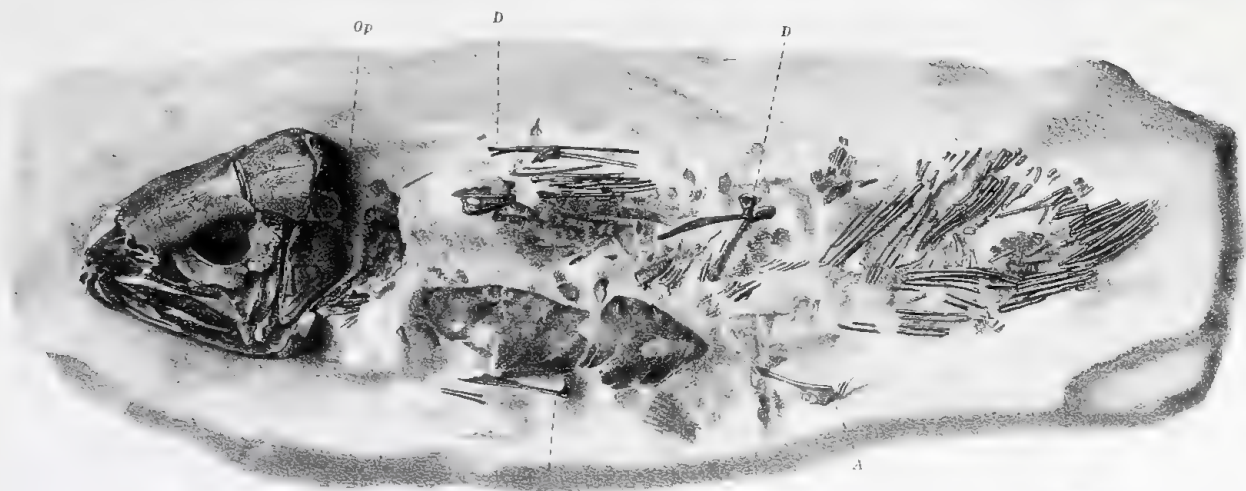
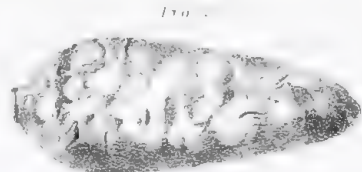
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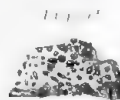
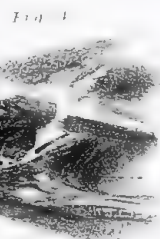
Coelacanthus elegans (Newberry) Figs 1-4.
Coelacanthus caudalis (Egerton) Fig. 5.
Coelacanthus elongatus (Huxley.) Figs 6-7.






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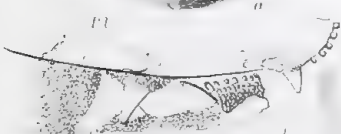
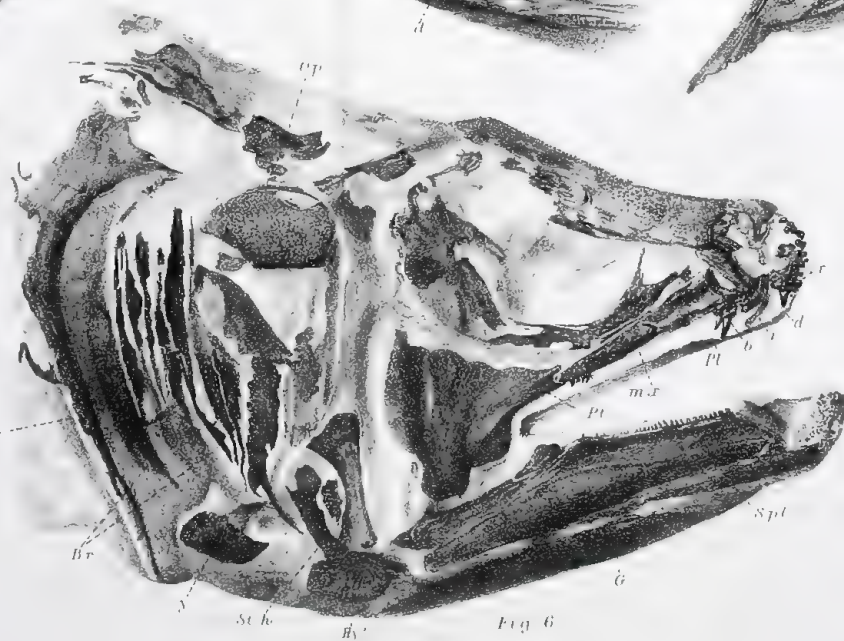


Fig. 3

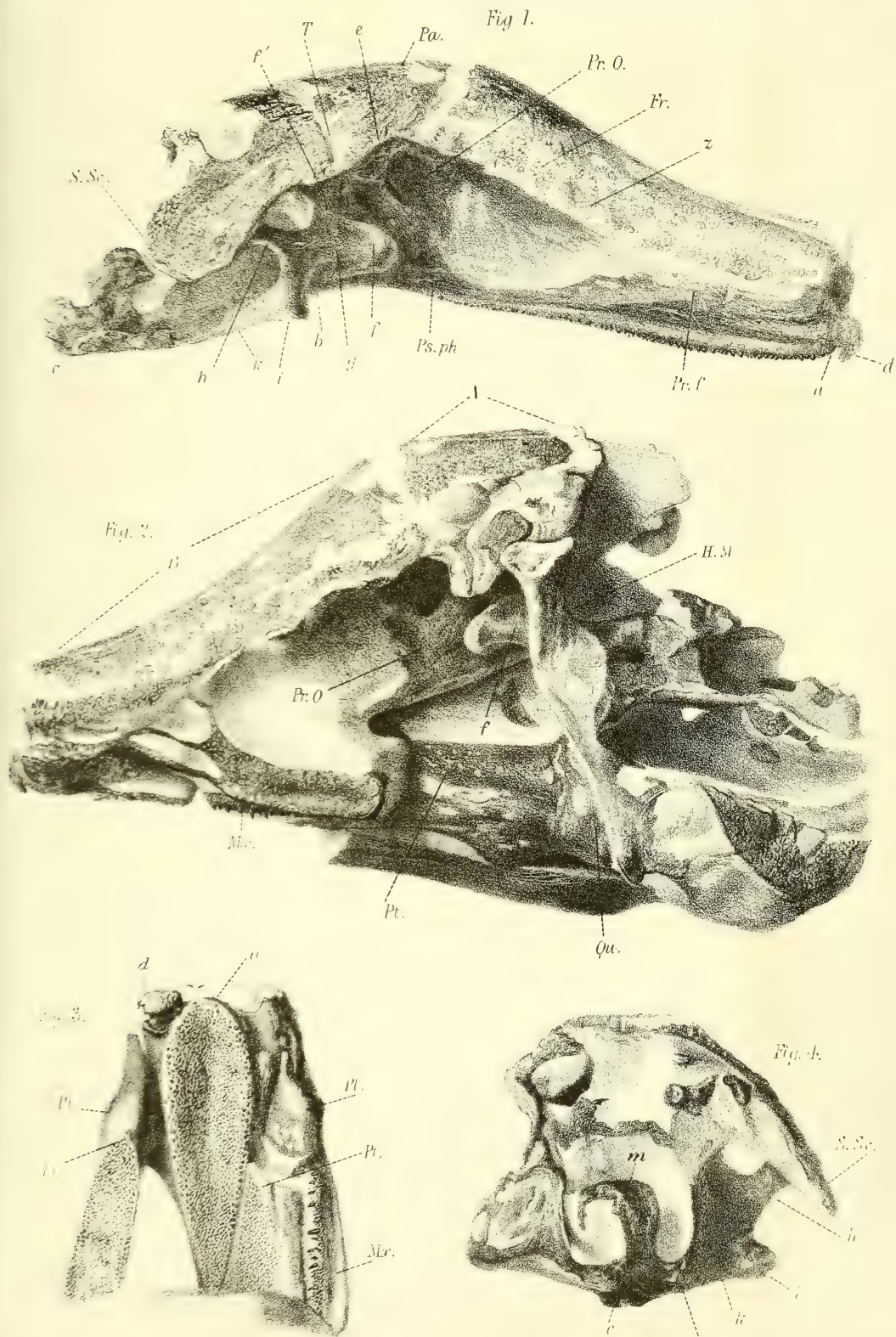


Fig. 5

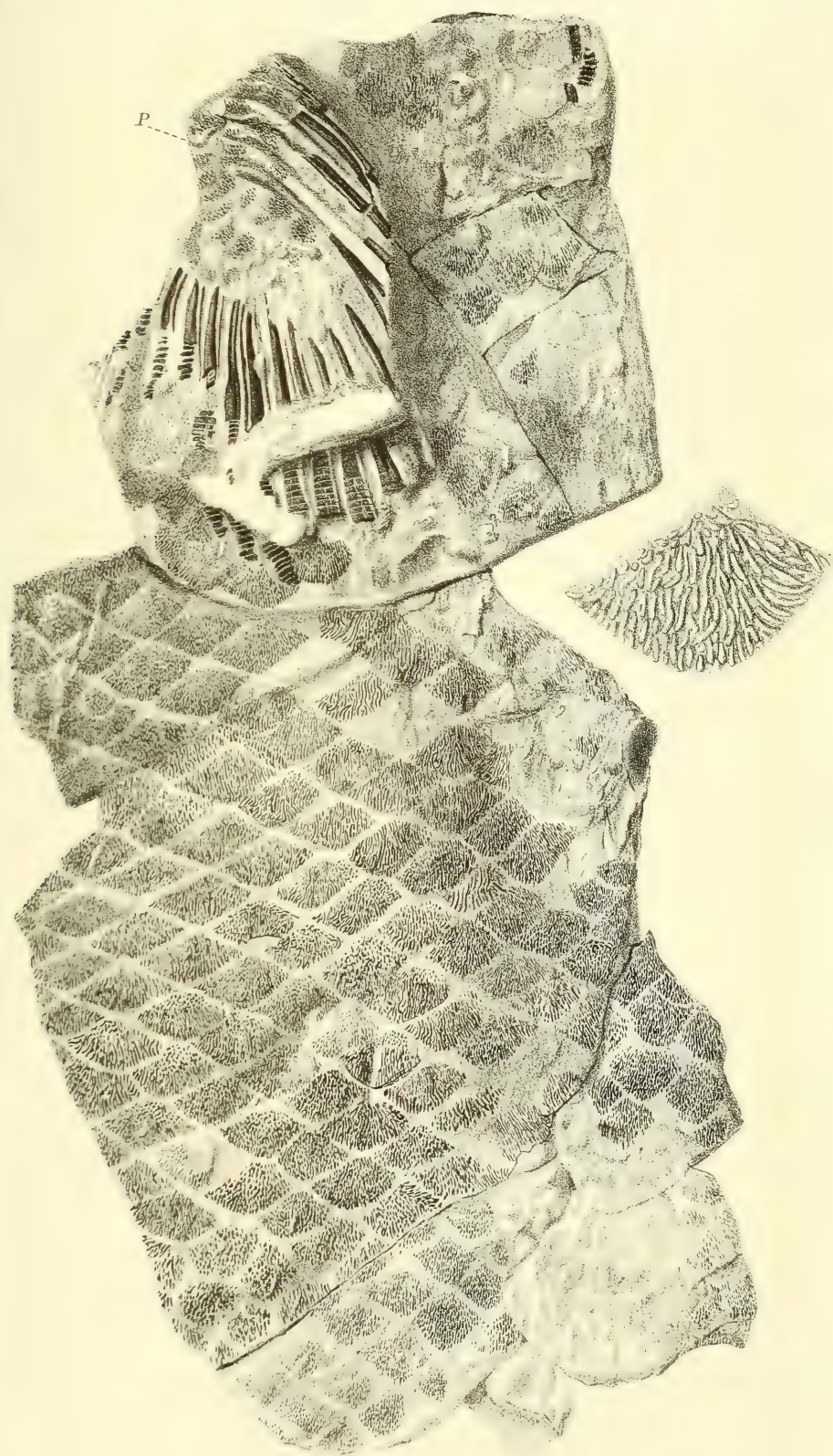


Page 6

Macropoma *Mantell* (*Agassiz*)



Macropoma Mantelli (Agassiz.)



Macropoma substriolatum (Huxley)

Fig. 1.

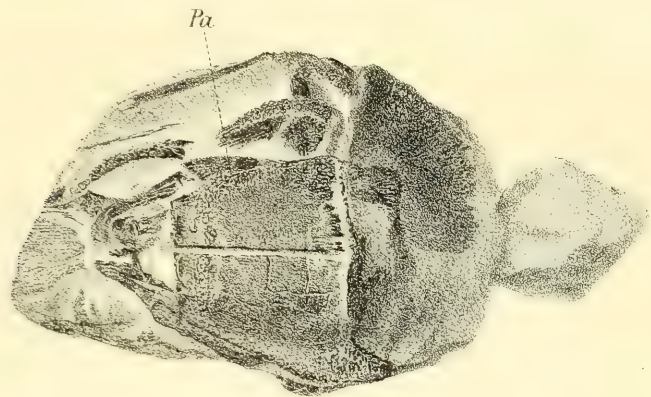


Fig. 2.

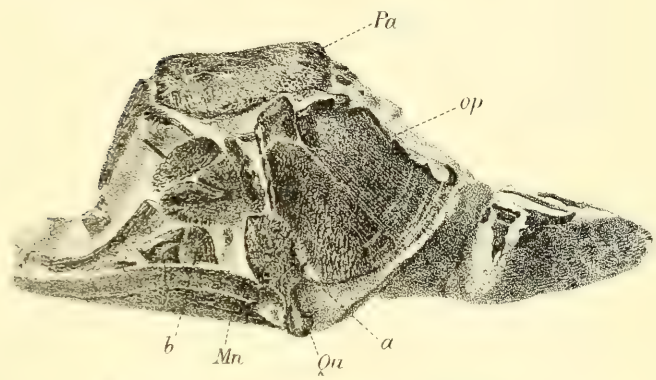


Fig. 3.

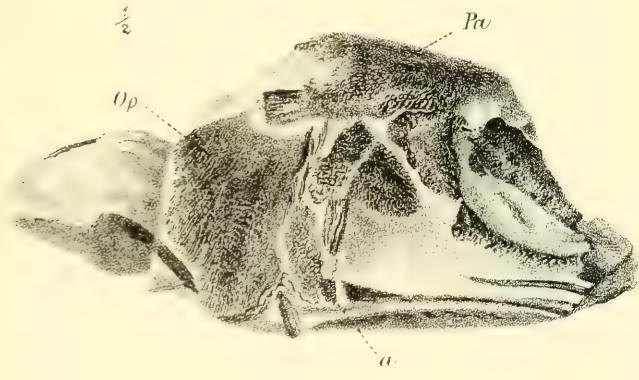
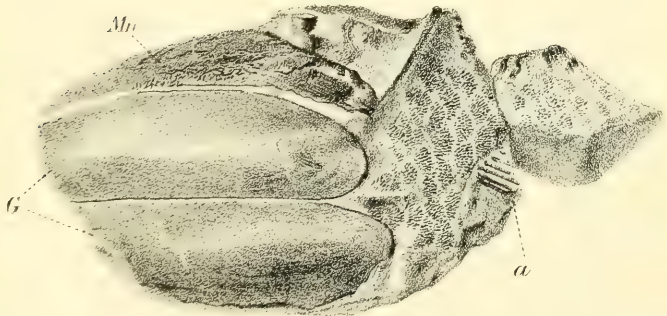


Fig. 4.



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PLATE VIII.

The skull of a *Macropoma Mantellii*. In the collection of the Earl of Enniskillen.

- Fig. 1. A view of the right side ; Fig. 2, of the left side ; Fig. 4, from behind.
 Fig. 3. The under surface, so far as the matrix allows it to be seen.

PLATE XI.

The body of *Macropoma substriolatum*, with a single scale, magnified. In the Woodwardian Museum, Cambridge.

PLATE X.

The head of the same specimen from above (Fig. 1), the sides (Figs. 2 and 3), and below (Fig. 4). One half the size of nature. In the Woodwardian Museum, Cambridge.

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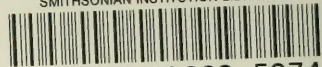
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